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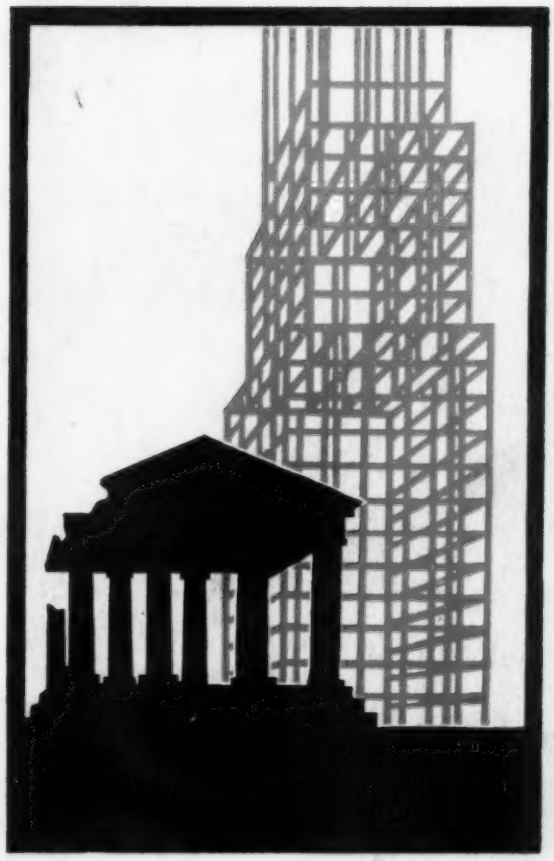

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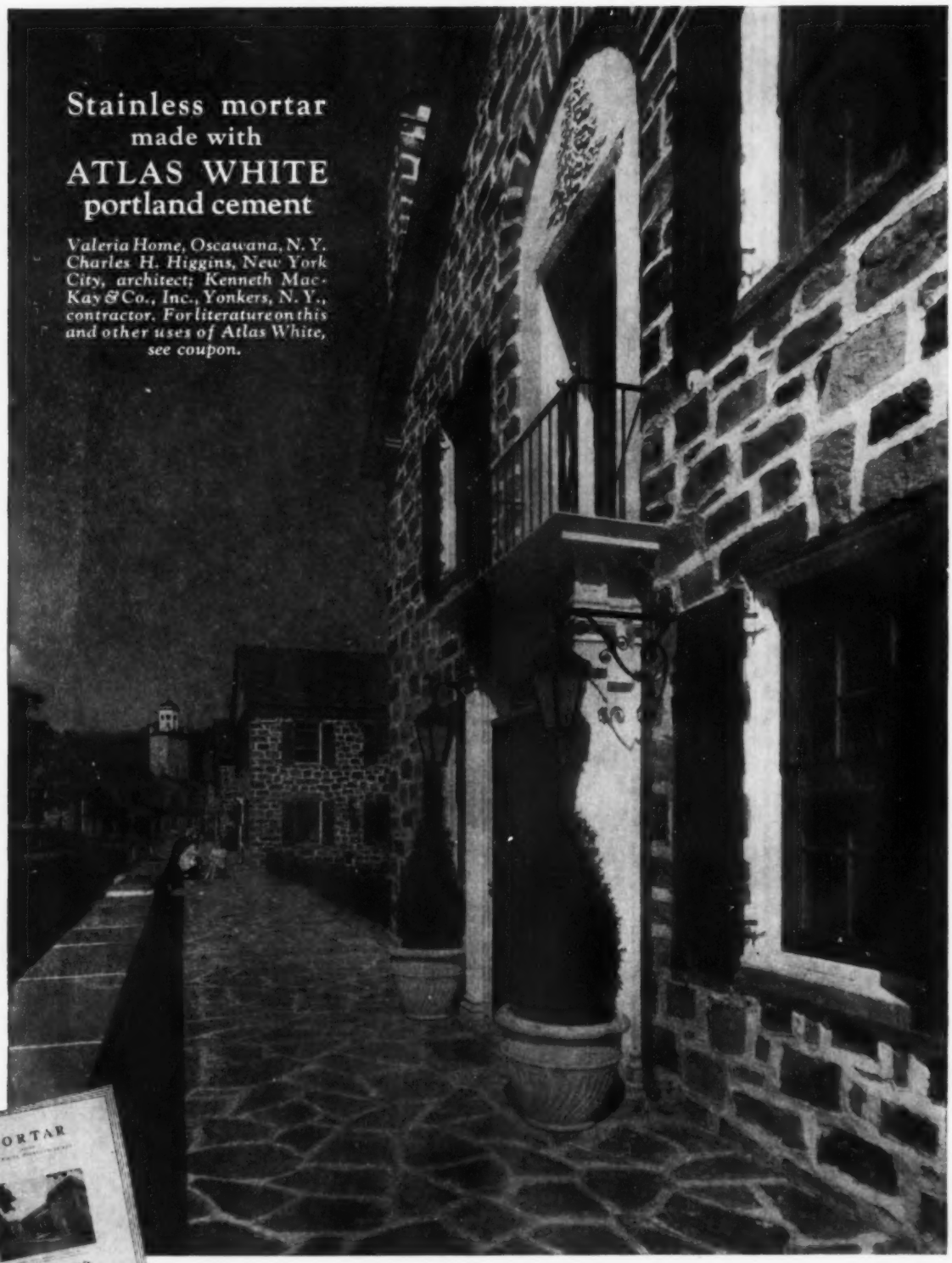

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THE ARCHITECTURAL RECORD

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VIEW OF PYLONS, SOLDIERS' AND SAILORS' MEMORIAL BRIDGE, HARRISBURG, PENNSYLVANIA; GEHRON AND ROSS, ARCHITECTS; RENDERING BY ERNEST BORN

THE ARCHITECTURAL RECORD

AN ILLUSTRATED MONTHLY MAGAZINE OF ARCHITECTURE & THE ALLIED ARTS & CRAFTS

VOLUME 67 MAY · 1930 NUMBER 5

SOME NOTES ON BRIDGE DESIGN

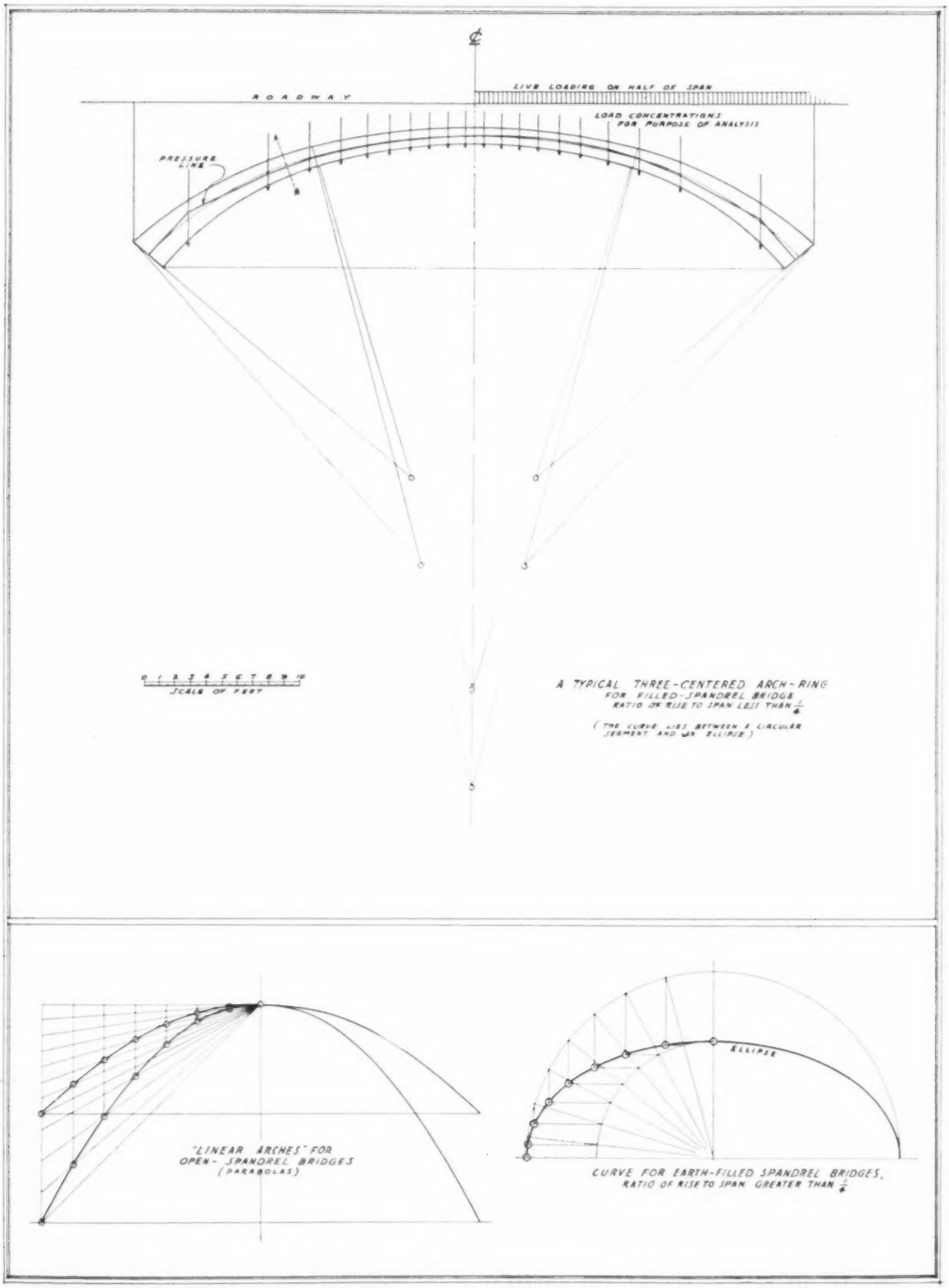
BY J. B. MASON

THE graceful long-span arch bridge is coming more into its own and adds greater possibilities to artistic design. Spans of three and four hundred feet are still rare enough to be matters of comment, but how much greater a thrill there will be in the artistic realization of the 1,000 and 2,000 foot spans now considered possible! Through utilization of the hinge or semi-hinge construction, the foremost exponents of which have been Considere, Mesnager and Freyssinet, greatly increased arch spans will become possible. Freyssinet states that by the use of his method, and under the 1916 regulations of the French Department of Public Works, plain concrete arches of 1,100-foot span, and reinforced concrete arches of 2,700-foot span, can be constructed without especial difficulties.

Effect can be achieved through correctly proportioned arches. There is something of a sense of soaring across space, of a greyhound leaping ahead. No type is more beautiful as an expression of this idea than the bow-string arch bridge. It is in the conception of such soaring arches, rightly placed, artistically proportioned, that architects should find much new and absorbing work. Through use of slender members a delicate tracery in concrete may be produced in some bridge designs which is very beautiful. As the strength of this material is more fully utilized, the employment of more delicate and frail-appearing tracery will increase, offering still greater possibilities in the future for artistic architectural design.

A study of recommended practices for exterior concrete finishes for monolithic type buildings will give information of value in bridge work. Architects will find it advisable to detail conspicuous surfaces carefully. The contractor must be required to use the best grades of tongue-and-groove lumber of uniform width for forms, and must be instructed to lay these boards horizontally with joints well broken. Oils and other materials which may discolor the concrete should be specified against. Careful study of the structure should be made to determine the proper width of form boards to be used as it is very evident that too wide pieces tend to make a structure look heavy and clumsy, while too narrow pieces may dwarf the design.

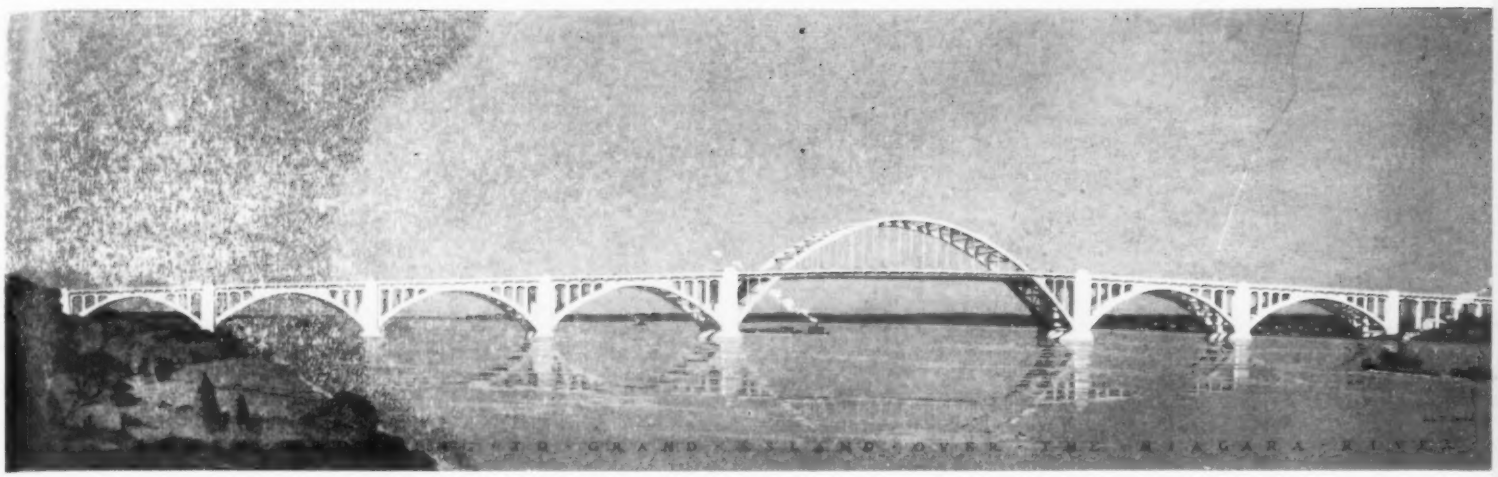
As soon as forms are removed the concrete may be brushed down with a wire brush and touched up to remove fins and construction dirt and give the exposed surfaces a clean appearance. Grinding rough surfaces with a portable carborundum outfit will often serve to improve the appearance of the bridge materially. Application of a cement wash followed by rubbing is possibly the most satisfactory method to give the bridge a clean white appearance.


℄
ROADWAY
LIVE LOADING ON HALF OF SPAN
LOAD CONCENTRATIONS FOR PURPOSE OF ANALYSIS
PRESSURE LINE
0 1 2 3 4 5 6 7 8 9 10
SCALE OF FEET
A TYPICAL THREE-CENTERED ARCH-RING FOR FILLED-SPANDREL BRIDGES RATIO OF RISE TO SPAN LESS THAN 1/4
(THE CURVE LIES BETWEEN A CIRCULAR SEGMENT AND AN ELLIPSE)
"LINEAR ARCHES" FOR OPEN-SPANDREL BRIDGES (PARABOLAS)
ELLIPSE
CURVE FOR EARTH-FILLED SPANDREL BRIDGES, RATIO OF RISE TO SPAN GREATER THAN 1/4

CORRELATION BETWEEN PRESSURE-LINES AND ARCH-RINGS IN THREE BRIDGE TYPES

DRAWING BY E. C. SEIBERT

(See article beginning on opposite page)



(See footnote for full credit)

THE DESIGN OF MASONRY ARCH BRIDGES

BY E. C. SEIBERT

Arch bridge design must, for best results, be the combined product of engineer and architect. Something beyond strict economy and efficiency is necessitated in the production of the highest degree of excellence, although it has been held that beauty resides in any useful structure designed on the lines of true economy, with the utmost simplicity and the fewest parts.

It must be borne in mind, however, that the design of a masonry arch is primarily an engineering matter, that the safe and economical curve of arch for any given set of conditions is fixed within narrow limits, and that, in the most common form of present-day masonry arch—the reinforced concrete structure—the proper disposition and proportioning of the steel reinforcement is a complex problem directly affecting the safety and economy of the structure.

An understanding of the fundamental action of an arch is necessary for the intelligent and successful treatment of its architectural features, for it is quite conceivable that an aesthetically sound design may be anything but structurally sufficient. A consideration of the action of an arch, and of the fixing of the arch curve, follows.

The Niagara Bridge shown above was built by the Niagara Frontier Bridge Commission; George C. Diehl, Inc., Engineers; Waddell and Hardesty, Consultants; Cass Gilbert, Inc., Consult. Architect.

An arch is a means of resolving, generally speaking, vertical (or nearly vertical) loads into diagonal thrusts.

The "curve" of an arch is dependent upon several factors, to wit: nature of loading; nature of the "ends" and crown (e.g. whether fixed or hinged); the way in which loads are brought to the chief "working member," the arch-ring; and the external limitations of span and rise. The term "curve" as commonly applied to arches is loosely used. It generally denotes either the curve of the intrados or that of the axial line.

Arches may have a hinge at each abutment and at the crown; at each abutment; or at the crown only. The "hinge" has a mathematical advantage in constituting a "control point" in design, for the thrust line for any condition of loading passes through the center of a hinge. A three-hinged arch is statically determinate and the pressure line due to any loading may readily be determined; in an arch with less than three hinges the fixing of the pressure line is not so simple a matter, while a hingeless fixed-end arch is statically indeterminate in the full sense of the term.

SPRING RIVER BRIDGE NEAR LOWELL, KAS.
A bow-string arch type of graceful design

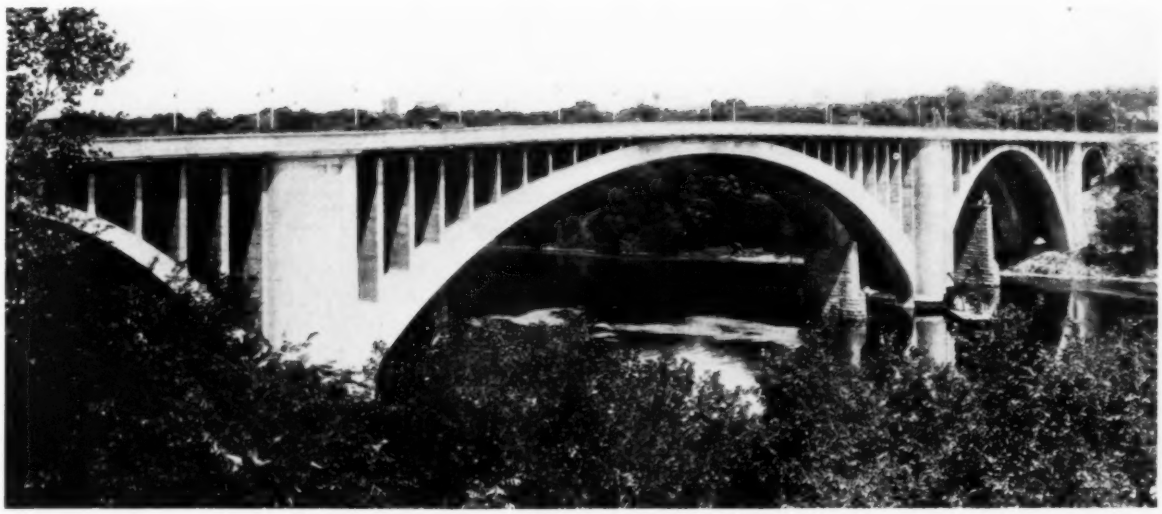
Aesthetically, a hinge is distinctly detrimental. A hinge can carry no bending moment; in a rib with three hinges the deepest section is required nearly midway between the spring and crown hinges, the section decreasing in depth toward the hinges where thrust and shear, but no moment, are carried. A mental picture suffices to convey the generally unsatisfactory result. In justice, however, it must be admitted that under conditions of easily compressible foundations, the three-hinge type permits of relatively greater settlement without injury. Also, for instances in which the rise is less than ¼ the span, the three-hinged arch economically is the better, because of the relatively much higher temperature stresses in the "fixed" arch. Also, since the temperature stresses in a three-hinged arch are practically nothing, and since it is statically determinate, higher unit stresses may be used than in the solid arch.

The hinged arch may thus be dismissed as a somewhat unbeautiful utility, promoting economy at a not inconsiderable cost to the seeing eye.

As above stated, a fixed arch is statically indeterminate. The unknown quantities are six in number: the magnitude, direction, and point of application of the reaction at each support. The well-known three conditions for static equilibrium (namely that the algebraic summation of horizontal components of all external forces acting, of their vertical components, and of all moments, must each equal zero) furnish but three equations. The three additional equations necessary for the discovery, by mathematical processes, of the six unknowns, express the conditions that one end of the arch ring (taken as the mathematical origin of coordinates) has, due to the bending moments on the various sections, zero horizontal, vertical, and rotary moments.

Equations derived from the above conditions are not used directly in arch computations but are essential in the derivation of the necessary working formulas.

Instead of actually finding the magnitude, direction, and point of application of the reactions at the supports, it is simpler to find the thrust, shear, and moment at the



CAPPELEN MEMORIAL BRIDGE, MINNEAPOLIS

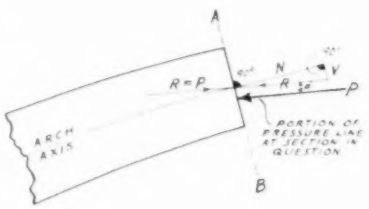
N. W. ELSBERG, CITY ENGINEER; K. OUSTAD, BRIDGE ENGINEER

A parabolic arch ring of excellent design. However, the use of a short-radius curve at the junction of the arch ring with the vertical line of the piers is criticized by Mr. Mason in his article on page 401, as a device that is generally ineffectual

crown. Having these, the equilibrium polygon under a given system of loads is drawn and the thrust, shear, and moment at any point may be found. This equilibrium polygon constitutes a picture of the internal forces acting on the ring. (In all arch theories the pressure line is assumed as coinciding with the equilibrium polygon. This is, practically speaking, true.)

If in designing an arch-ring, the equilibrium polygon for the given loads and the arch axis do not closely approach each other, further trial curves must be drawn until there is a close coincidence. The closer this coincidence, the lower the stresses in the ring.

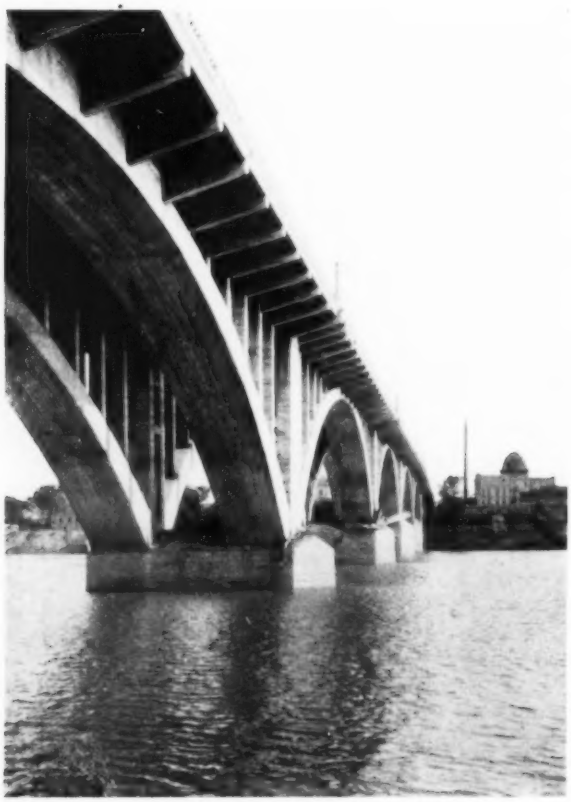
The magnitude and direction of the thrust at any particular section may be obtained by computation, or graphically. Consider



any such section A-B of the arch-ring shown in the drawing (page 402). An enlargement of this section in shown herewith, and conditions have been somewhat exaggerated for the sake of clearness. The resultant of all external forces is represented in magnitude and direction by P, which produces on the section in question a moment R d, a thrust N, and a shear V.

Now it is evident, upon examination of the figure, that the bending moment is zero at points where the equilibrium polygon intersects the arch axis, and furthermore, that if the equilibrium polygon is normal to a section, there will be no shear at that particular section. However, there is at least a thrust at every section.

In addition to the effects of the loads on an arch, tending to shorten the span of the arch, temperature changes tend to shorten the span when the temperature falls, and to lengthen it when the temperature rises. Now the tendency for the span to change its length, due to any cause, results in certain thrusts and moments. These vary with the form of the arch. In this connection, suffice it to say that in general, these effects are greater for a flat arch, as are the effects of loadings, and that formulae for their determination have been developed, and are available in any good treatise.



MAIN STREET BRIDGE, LITTLE ROCK, ARK.
DANIEL B. LUTEN, ENGINEER

A parabolic arch type. Photo taken shortly after flood water had subsided, leaving abutments piled with debris. A minor fault in a good design.

•

It is well known that a thrust acting outside of the middle third of a section causes a tendency to tension. Of course, in a masonry arch of material or construction incapable of taking tension, the design must be such as to keep the thrust within the middle third, but in concrete, sections may be, and generally are, designed for tension by the inclusion of steel reinforcement, at both the top and bottom.

From the above, it will be evident that the curve of the axial line of an arch should conform as nearly as possible to the "pressure line" under the given load system. Now each condition of loading in a highway or railroad bridge produces its own pressure line. If a load moves across a bridge, the pressure line continually changes with the progress of the load. Hence no arch curve can satisfy perfectly all load conditions; the best curve, generally, is that which most nearly coincides with the mean of all possible pressure curves.

The two "linear" arches or pressure lines obtaining under common conditions of dead loading are the parabola and the transformed catenary. For equal load concentrations, equally spaced, the linear arch closely coincides with a parabola whose vertex is at the crown; this curve is exemplified by the open-spandrel bridges.

When the dead load along the rib varies in direct proportion to the distance between a horizontal line and the arch-ring, which is approximately the dead load condition in a filled spandrel arch, the linear arch assumes the shape of a transformed catenary.

The two curves above referred to are those obtaining under dead loads alone, and may be more or less modified by live load effects. Actually, load conditions are in practically all cases such as to render the use of one of the following curves satisfactory: for open spandrel arches, a parabola; for earth-filled arches having a ratio of rise to span greater than $\frac{1}{4}$, an ellipse; for earth-filled arches having a ratio of rise to span of less than $\frac{1}{4}$, the best curve lies between a circular segment and an ellipse, and may be approximated by a three-centered intrados.

For the sake of appearance, the parabolic curve is sometimes modified by short circular curves at its ends, made tangent to the parabola and to the vertical line of the pier or abutment. Such minor curves are not effective, and in no case should be considered as part of the arch rise.

In highway bridges the following live load conditions are generally used in determining the maximum effects: first, live load covering the entire span, and second, the load covering but one-half the span. Or, by computing a table for the thrusts and moments due to a load of unity at different points, or by the use of influence lines, the exact loading to cause maximum stresses may be determined. Of course, the dead load stresses are always to be considered in conjunction with those from moving loads.

In judging the fitness and beauty of an arch bridge, the pleasing and load carrying qualities of the curve of the arch-ring are not the only considerations. The following points, placed in an order not necessarily one of relative importance, must be considered by the designer:

(a) Adequacy of waterway. Also, is the form such as to catch debris at high water?
(b) Adequacy of head-room.
(c) Is the design the most economical and appropriate one for the natural conditions at the site?
(d) Is the type the most suitable for the loading?
(e) Does the bridge bespeak the character of the community?
(f) Does it harmonize with surroundings, as regards the rugged, ornamental, or simple character of surrounding country?
(g) Is it symmetrical in the proper sense of the term? If not geometrically symmetrical, is its general shape adapted to the natural profile of the waterway and valley it spans?
(h) Does it convey an impression of strength, and of proper use of materials?
(i) Is there an incongruous combination of trusses with girders?
(j) Does each arch of a multiple-arch bridge harmonize with the others? Are "full centered" (springing from horizontal beds) spans adjacent to skewbacks (springing from inclined beds)?
(k) Is the roadway agreeably cambered? (A flat parabola is very agreeable).
(l) Are piers pleasingly proportioned, and do they have efficient lines for minimum practicable resistance to the flow?
(m) Is the arch-ring correctly and gracefully proportioned and is it properly accentuated in a manner in keeping with its importance?
(n) Is there a "dominating" span?
(o) Do the abutments have the appearance of ample strength?
(p) Are inappropriate figures, or other inappropriate ornamentation used, such as keystones and imitation voussoirs?
(q) In open spandrel bridges, is there an appropriate increase in the distance between columns, from the crown toward the springing lines?
(r) Is the railing adequate for protection to traffic and is it in keeping with the general character of the structure?
(s) Do pedestals appear to be developments of the piers and abutments?
(t) Are lamps in keeping with the general design, and are they pleasingly spaced?

The above points need not be elaborated upon. They are suggestive of the multiplicity of items requiring consideration in the architectural development of the arch bridge.

KILL VAN KULL BRIDGE, BAYONNE, N. J., TO PORT RICHMOND, STATEN ISLAND. BUILT BY THE PORT OF NEW YORK AUTHORITY
O. H. AMMANN, BRIDGE ENGINEER CASS GILBERT, INC., ARCHITECT

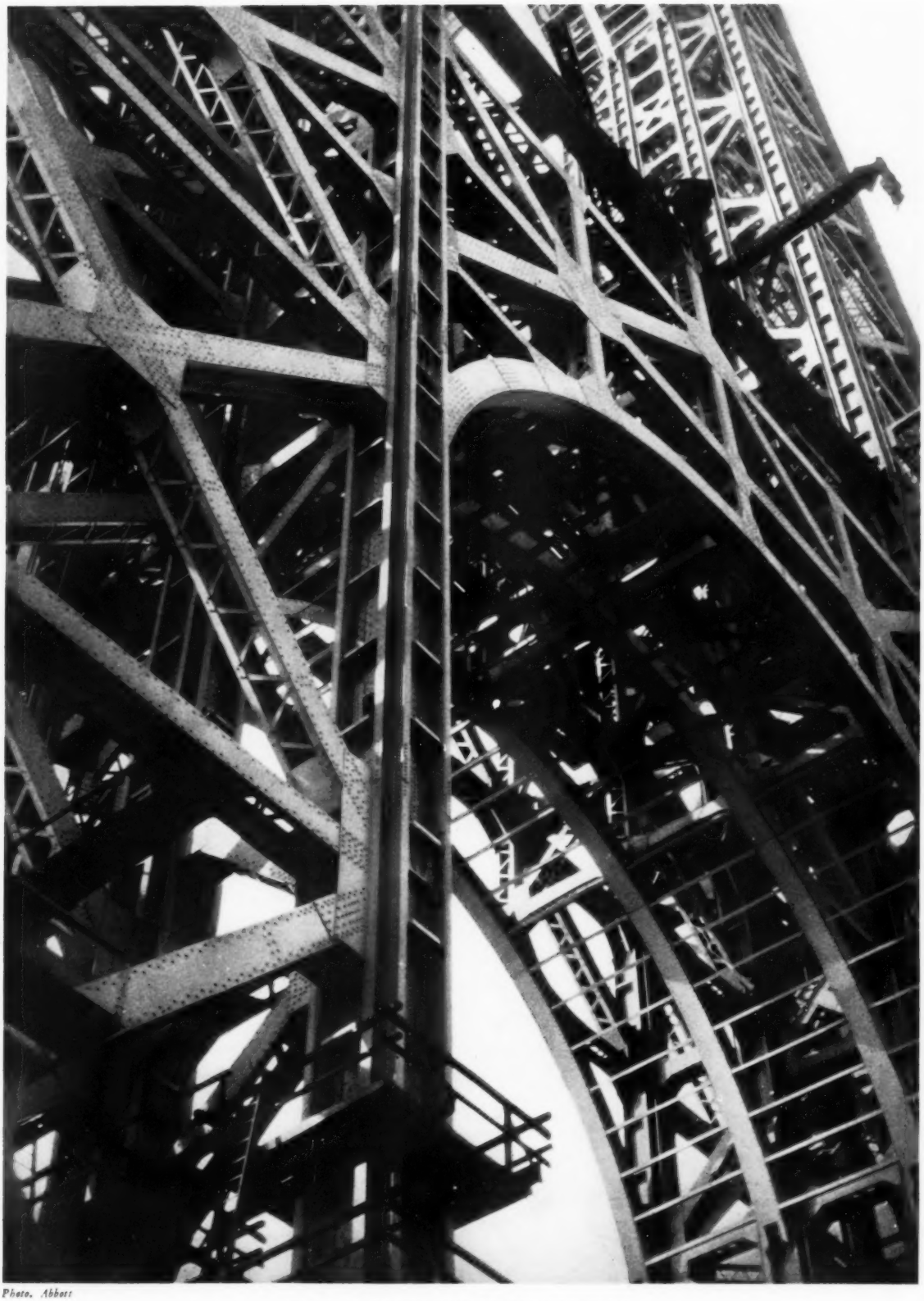


Photo. Abbott

VIEW OF TOWER UNDER CONSTRUCTION

HUDSON RIVER SUSPENSION BRIDGE, NEW YORK CITY

Built by the Port of New York Authority

O. H. AMMANN, BRIDGE ENGINEER CASS GILBERT, INC., ARCHITECT

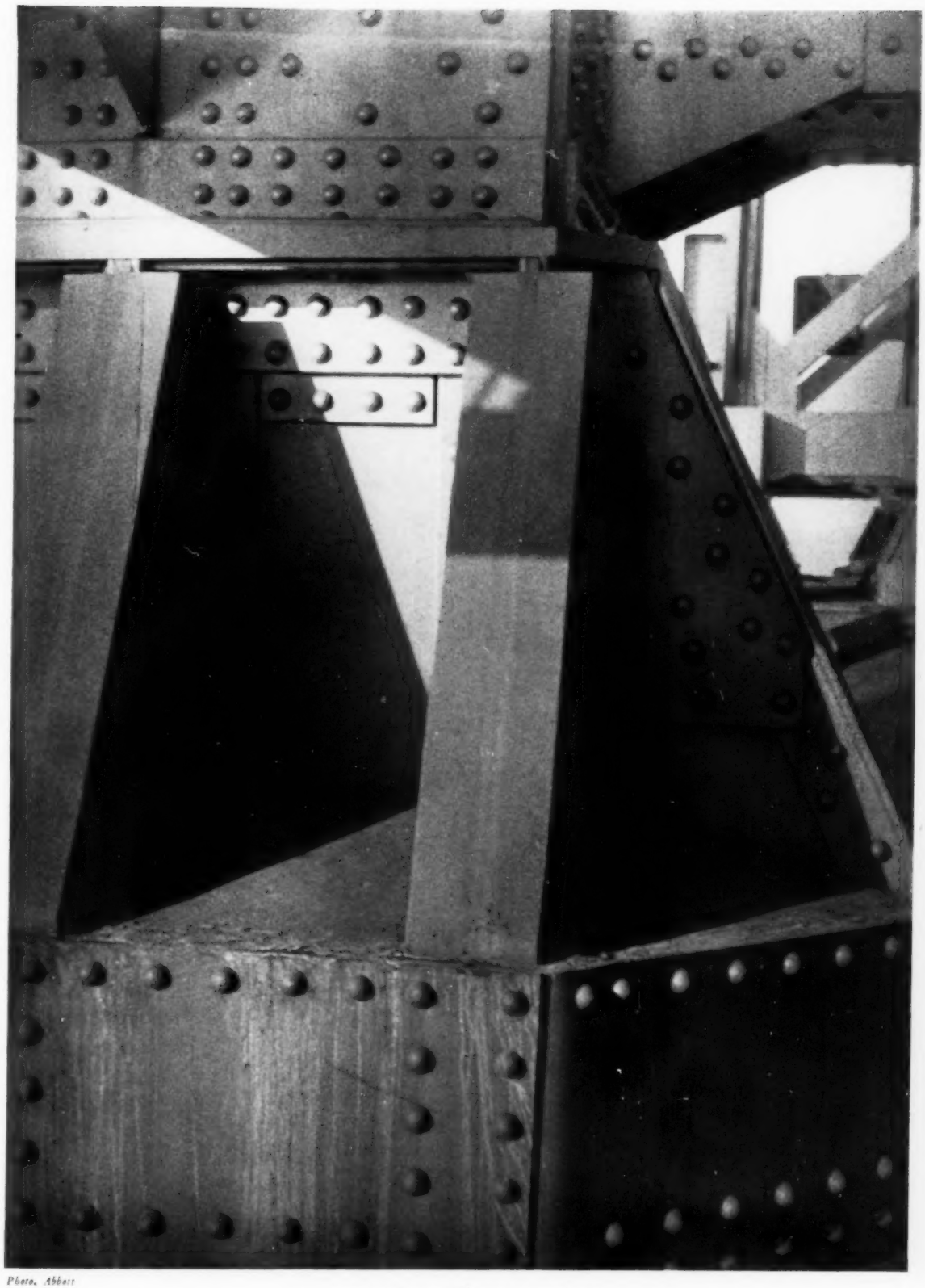


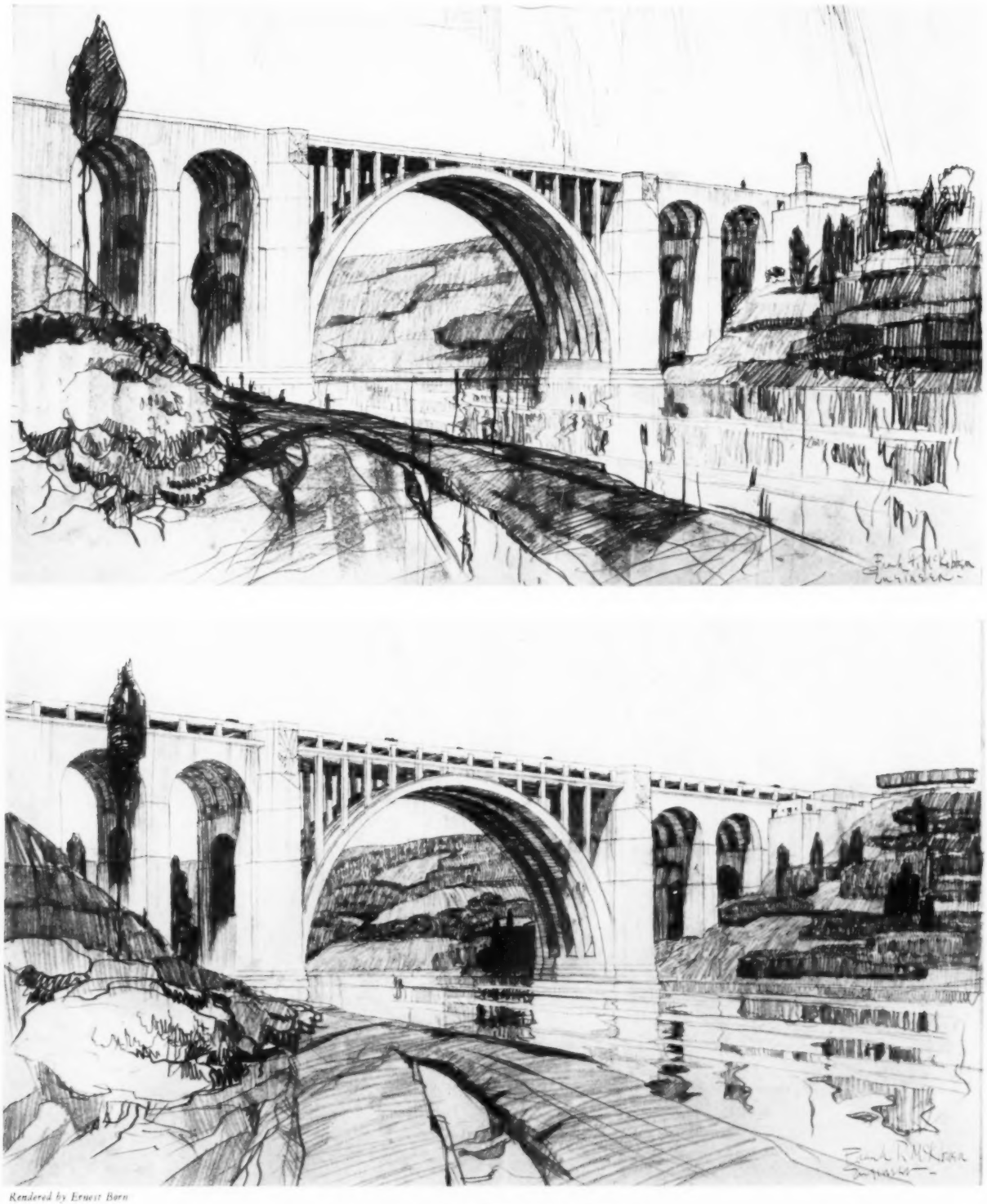
Photo. Abbott

DETAIL OF STRUCTURAL STEEL

HUDSON RIVER SUSPENSION BRIDGE, NEW YORK CITY

Built by the Port of New York Authority

O. H. AMMANN, BRIDGE ENGINEER CASS GILBERT, INC., ARCHITECT



Rendered by Ernest Born

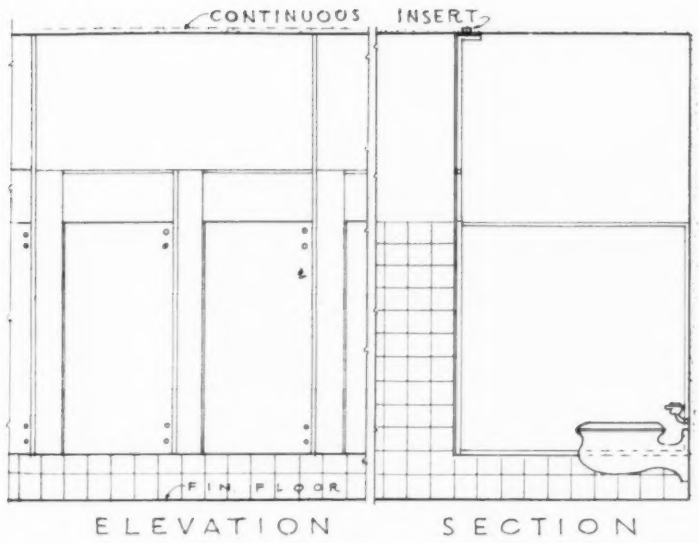
STUDIES FOR RIDGE ROAD BRIDGE

OVER THE GENESSEE RIVER, ROCHESTER, NEW YORK

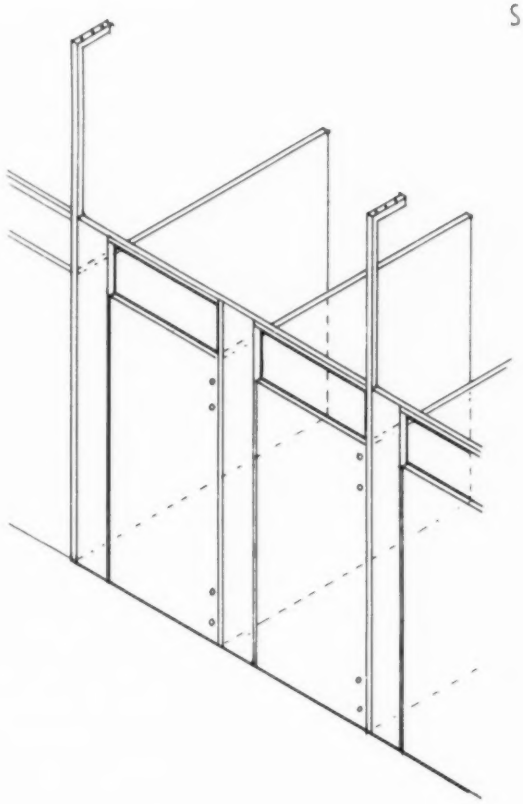
GEHRON AND ROSS, ARCHITECTS, FRANK P. MC KIBBEN, ENGINEER

Both of these studies are made for concrete construction throughout. The top design is for a single deck roadway, and the lower design is for a double deck roadway, which was abandoned on account of the difficulties at the approaches. This bridge is now being built with closed spandrels and is being faced with granite

NOTES ON DRAFTING AND DESIGN



SUSPENDED METAL STALL PARTITIONS
K. L. H. SYSTEM

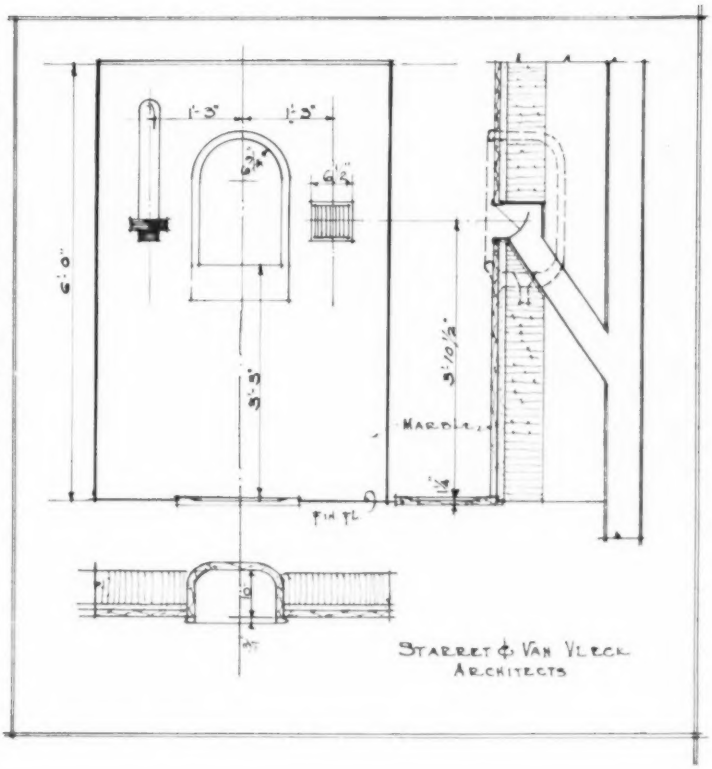


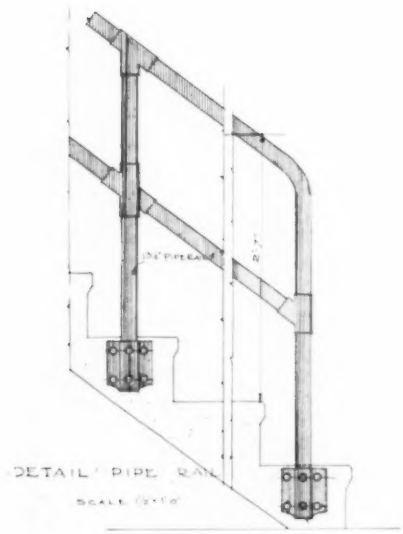
HANG IT

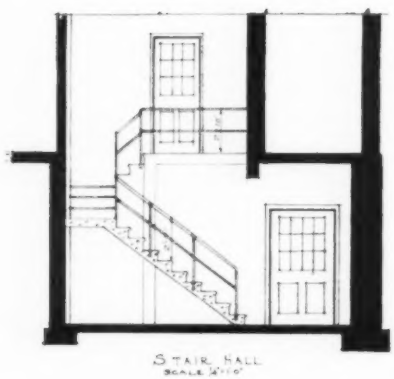
Toilet floors must be easily cleaned. Any construction that makes for unsanitary dirt-corners should therefore be avoided. Wall-hung closets, lavatories, etc., and metal stall partitions suspended from the ceiling leave the floor free for any obstructions to efficient cleaning. K. Lönberg-Holm, Architect.

DISCARD FOR DRINKING CUPS

To avoid the accumulation of used paper drinking cups adjacent to the drinking fountains in public hallways and offices, chutes should be built into walls. A barrel at the bottom of the chute gathers cup litter at one place and does away with janitor service required to empty baskets usually placed at each drinking fountain. Design by Starret and Van Vleck, Architects, New York City.







WHY WORK SO HARD DRAFTING?

The 1½″ scale detail of a stair rail at the left represents 1 hour's work on the drafting board. The detail does not give any essential information that is not already given on the ¼″ section or which could not be covered in the specification with a few words: "Rails to be two-pipe 1¾″ pipe rail."

Furthermore the detail might prevent the contractor from using more satisfactory welded connections or simpler flange attachments.

A large part of the working drawings required for the erection of present day structures are prepared in the architect's office.

A number of units that enter into the finished structure are not detailed by the architect nor shown on his drawings. They are covered by the specification either stating requirements or allowing choice among a given number of standard products. This includes mechanical and sanitary fixtures, structural units, hardware.

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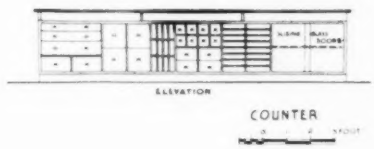
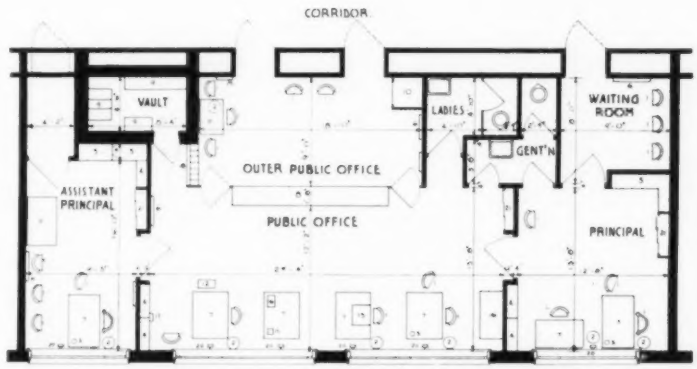
SCHOOL OFFICES A UNIT

Space can be conserved and the control of teaching functions furthered by concentrating all school administrative offices with their equipment in one compact unit. The scheme here illustrated was originated by Professor N. L. Engelhardt, Teachers College, Columbia University, in co-operation with an architect.





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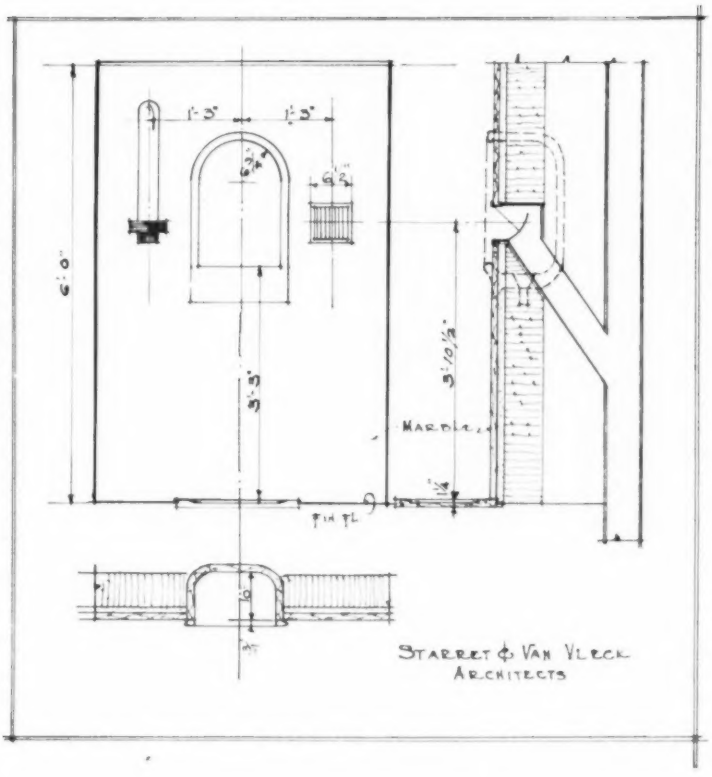
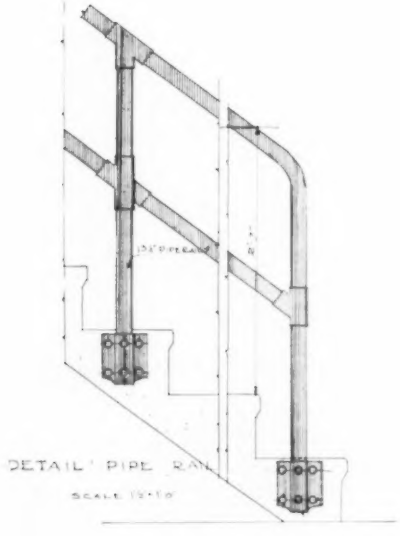
7 OFFICE DESK
8 COUNTER
9 SHELF
10 TELEPHONE BOOTH
11 TABLE
12 SWITCH BOARD
13 TYPEWRITER
14 LONGCARRIAGE TYPEWRITER
15 ADDING MACHINE
16 MIMEOGRAPH
17 WALL CLOCK
18 MAIL BOX
19 KEY BOARD
20 BASE BLOCK
21 CLOAK SPACE

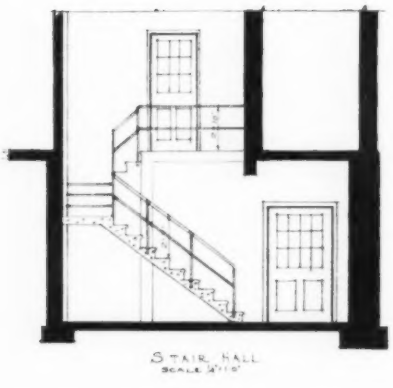
ADMINISTRATIVE SUITE FOR HIGH SCHOOL

DISCARD FOR DRINKING CUPS

To avoid the accumulation of used paper drinking cups adjacent to the drinking fountains in public hallways and offices, chutes should be built into walls. A barrel at the bottom of the chute gathers cup litter at one place and does away with janitor service required to empty baskets usually placed at each drinking fountain. Design by Starret and Van Vleck, Architects, New York City.







WHY WORK SO HARD DRAFTING?

The 1½″ scale detail of a stair rail at the left represents 1 hour's work on the drafting board. The detail does not give any essential information that is not already given on the ¼″ section or which could not be covered in the specification with a few words: "Rails to be two-pipe 1¼″ pipe rail."

Furthermore the detail might prevent the contractor from using more satisfactory welded connections or simpler flange attachments.

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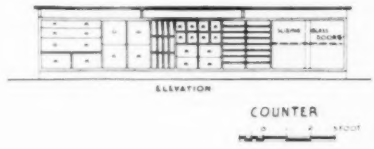

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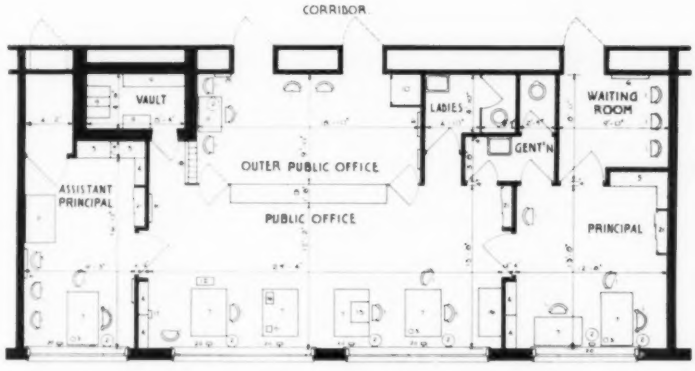

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ADMINISTRATIVE SUITE FOR HIGH SCHOOL

THE ALLIED ARTS:

Three Interiors

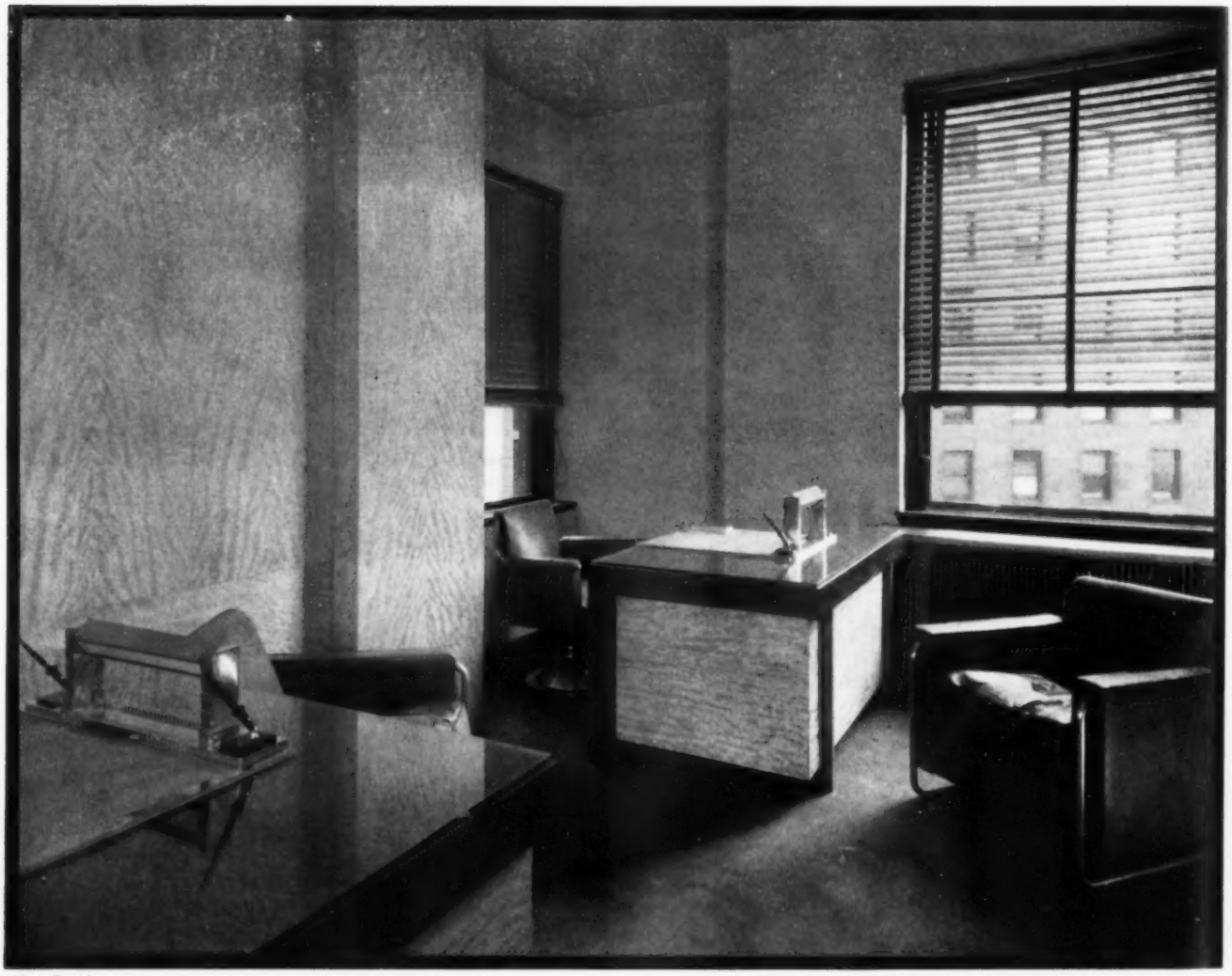


Photo. Danielson

OFFICE OF STRAUSS AND COMPANY, NEW YORK CITY

WHITMAN AND GOODMAN, ARCHITECTS

The woods employed are *avadoire* (pale yellow in color) and redwood burl; chairs nickel-plated and upholstered in green leather; the carpet is green.

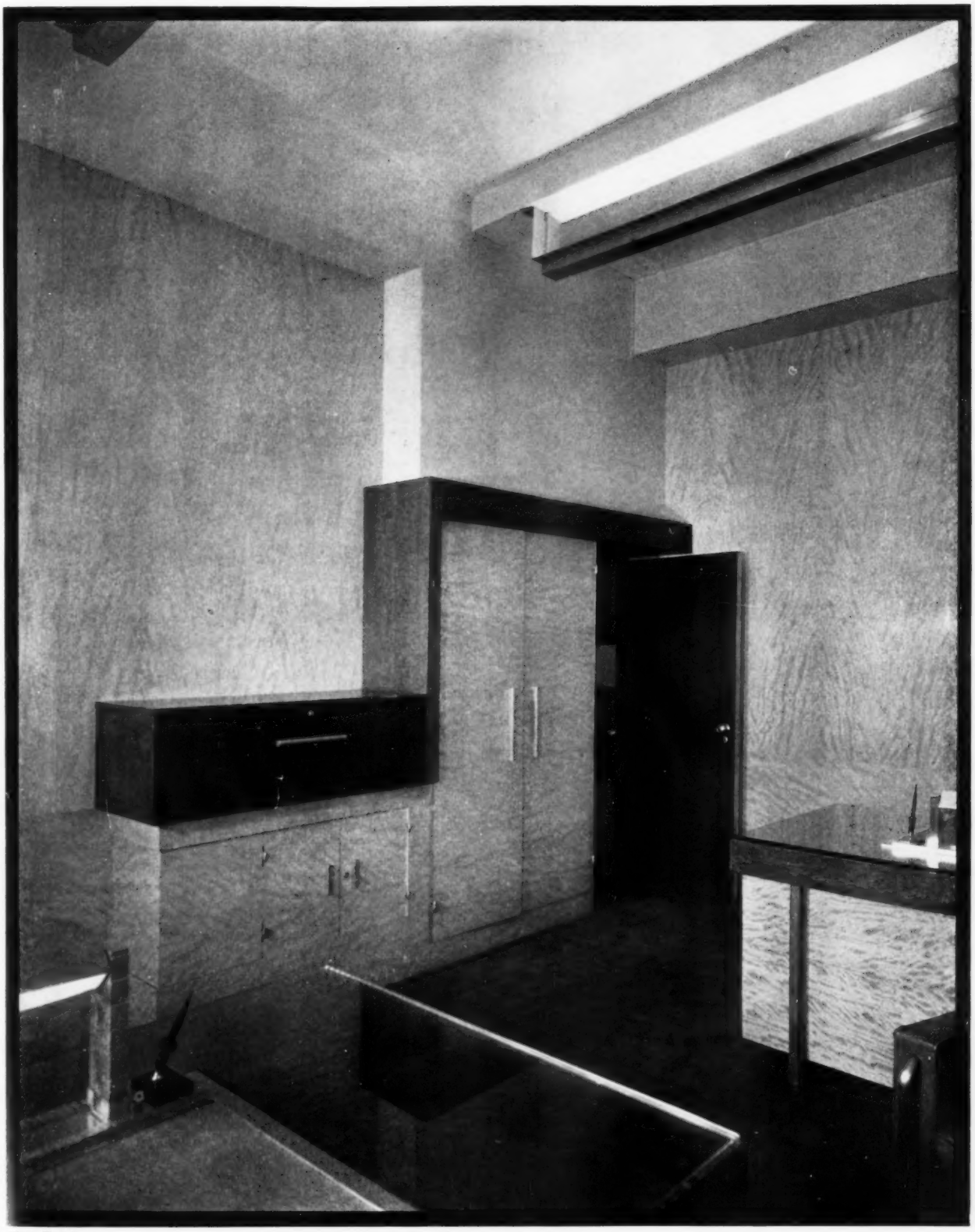


Photo. Danielsen

OFFICE OF STRAUSS AND COMPANY, NEW YORK CITY

WHITMAN AND GOODMAN, ARCHITECTS

Photo. Van Anda

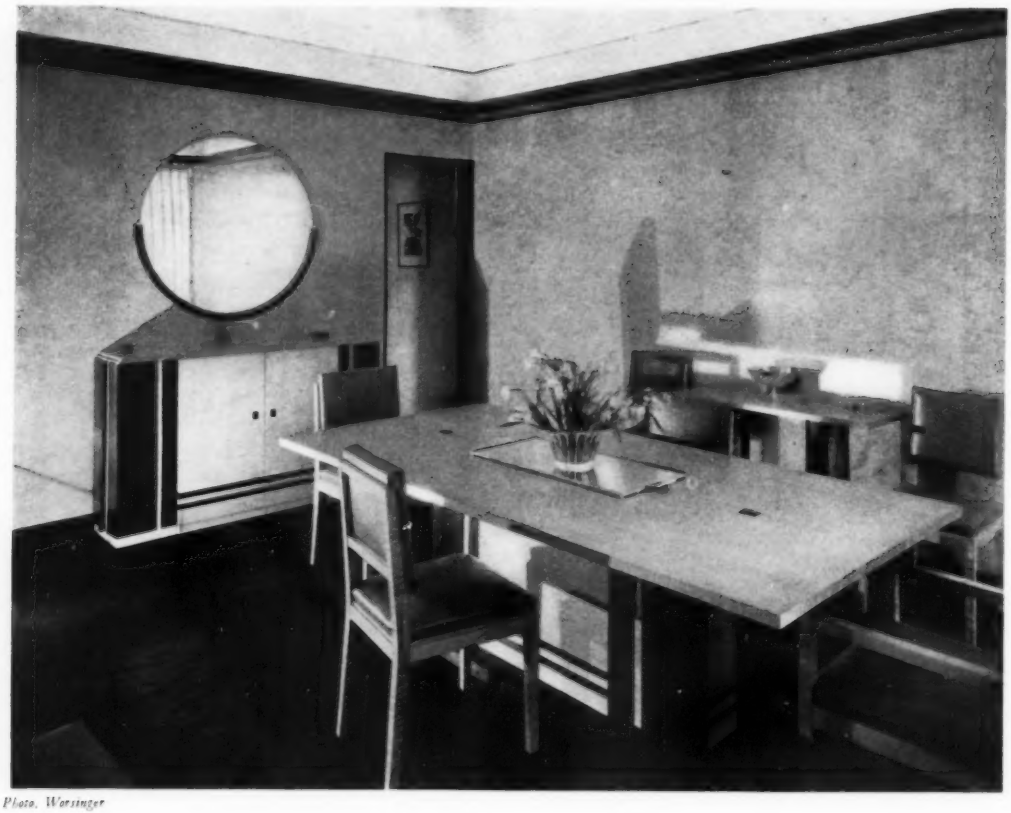


Photo. Worsinger

Above:
JOHN BECKER'S ART GALLERY, NEW YORK CITY
WOLFGANG AND POLA HOFFMANN, ARCHITECTS

Picture panels in natural Monk's cloth; room is in various shades of tan and brown.

Below:
DINING ROOM APARTMENT, NEW YORK CITY
DONALD DESKEY, DESIGNER

CURRENT ARCHITECTURE

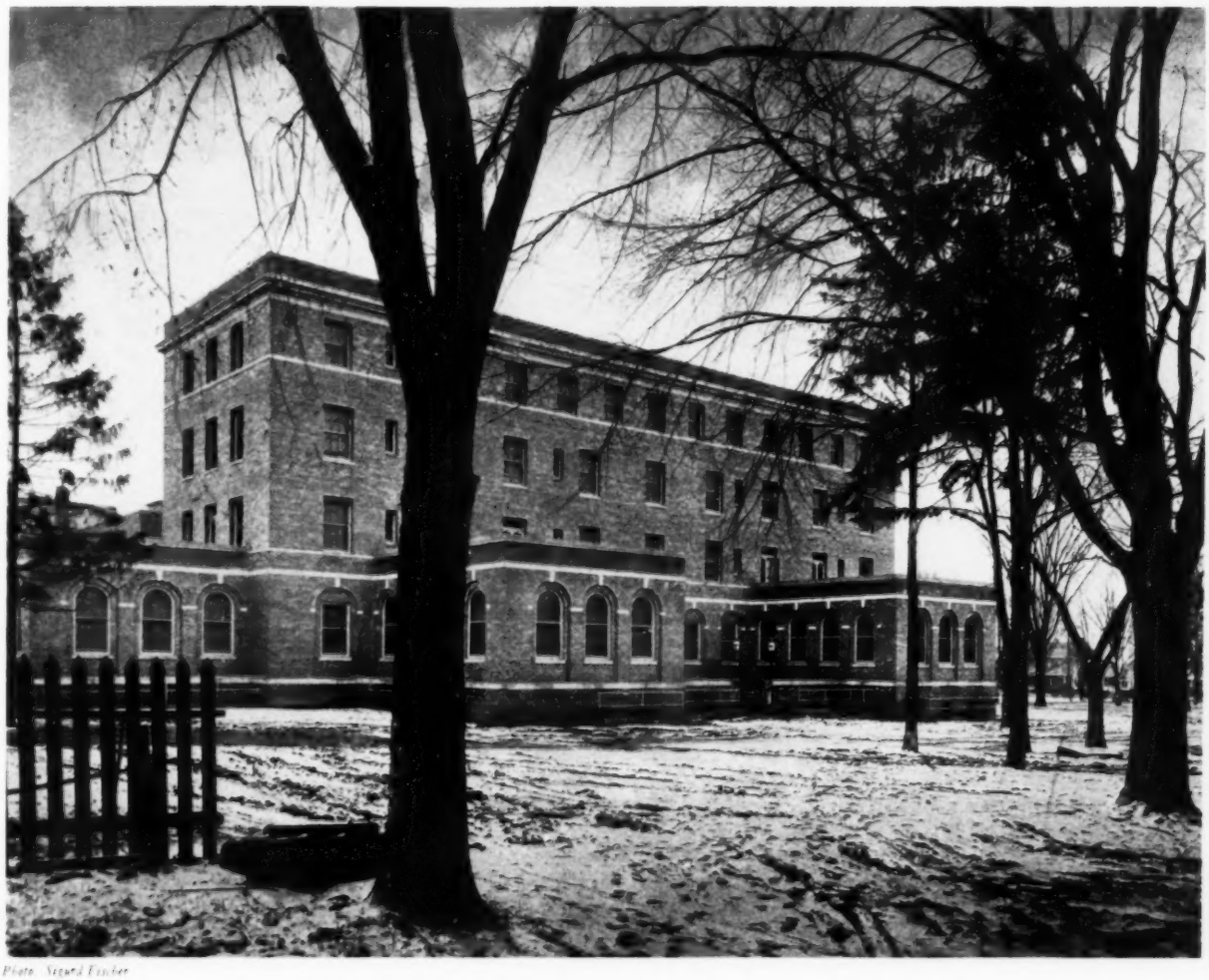


Photo Steward Fischer

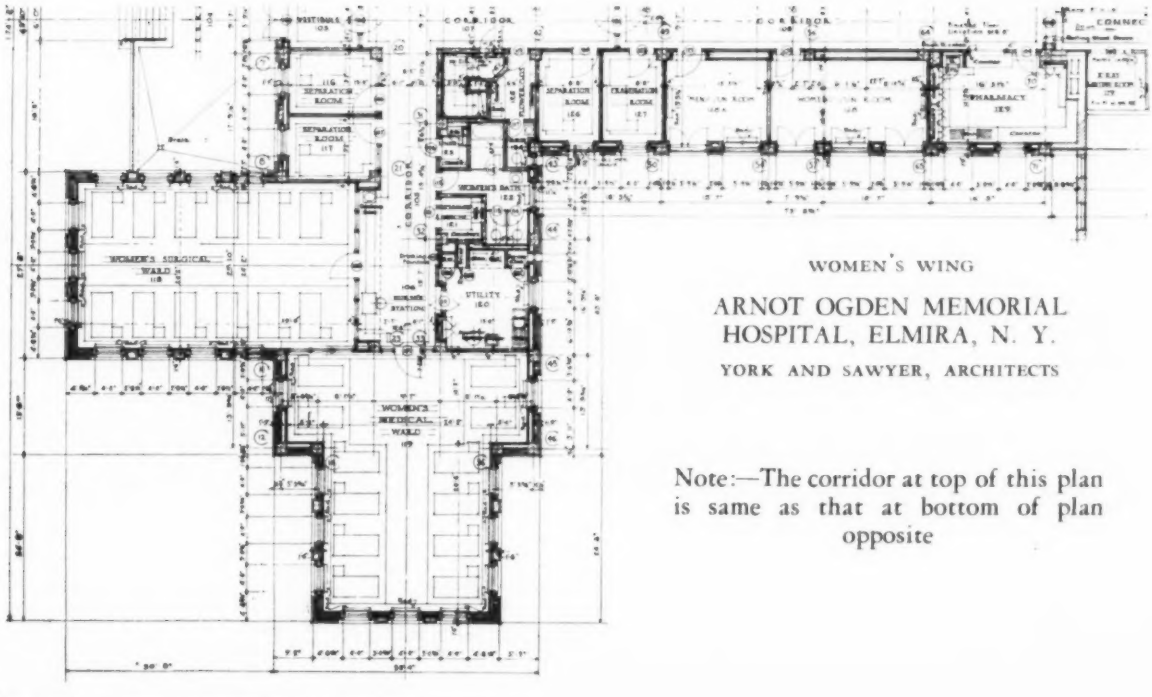
THE ARNOT OGDEN MEMORIAL HOSPITAL, ELMIRA, N. Y.
YORK AND SAWYER, ARCHITECTS

Featuring

THE ARNOT OGDEN HOSPITAL
THE BETH ISRAEL HOSPITAL
THE SYDENHAM HOSPITAL
ALTERATIONS IN THE HOTEL ADOLPHUS

Photo Sigurd Fischer

WOMEN'S SURGICAL WARD



WOMEN'S WING

ARNOT OGDEN MEMORIAL HOSPITAL, ELMIRA, N. Y.

YORK AND SAWYER, ARCHITECTS

Note:—The corridor at top of this plan is same as that at bottom of plan opposite

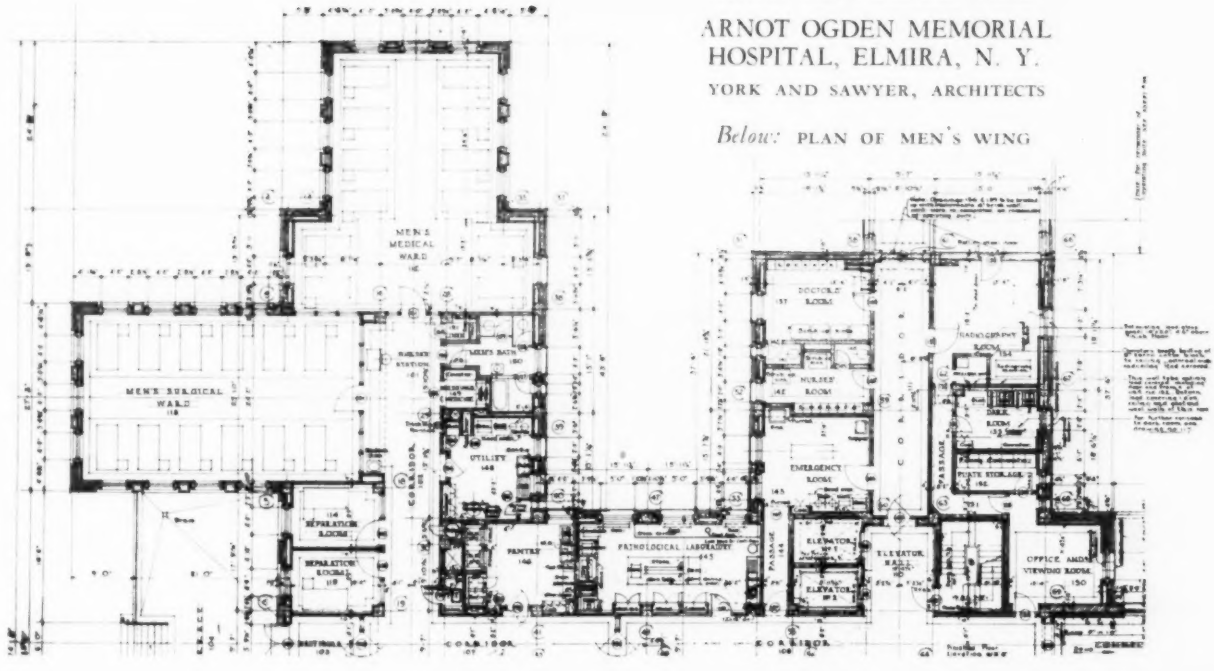
Photo. Sigurd Fischer

Above: MEN'S MEDICAL WARD

ARNOT OGDEN MEMORIAL HOSPITAL, ELMIRA, N. Y.

YORK AND SAWYER, ARCHITECTS

Below: PLAN OF MEN'S WING



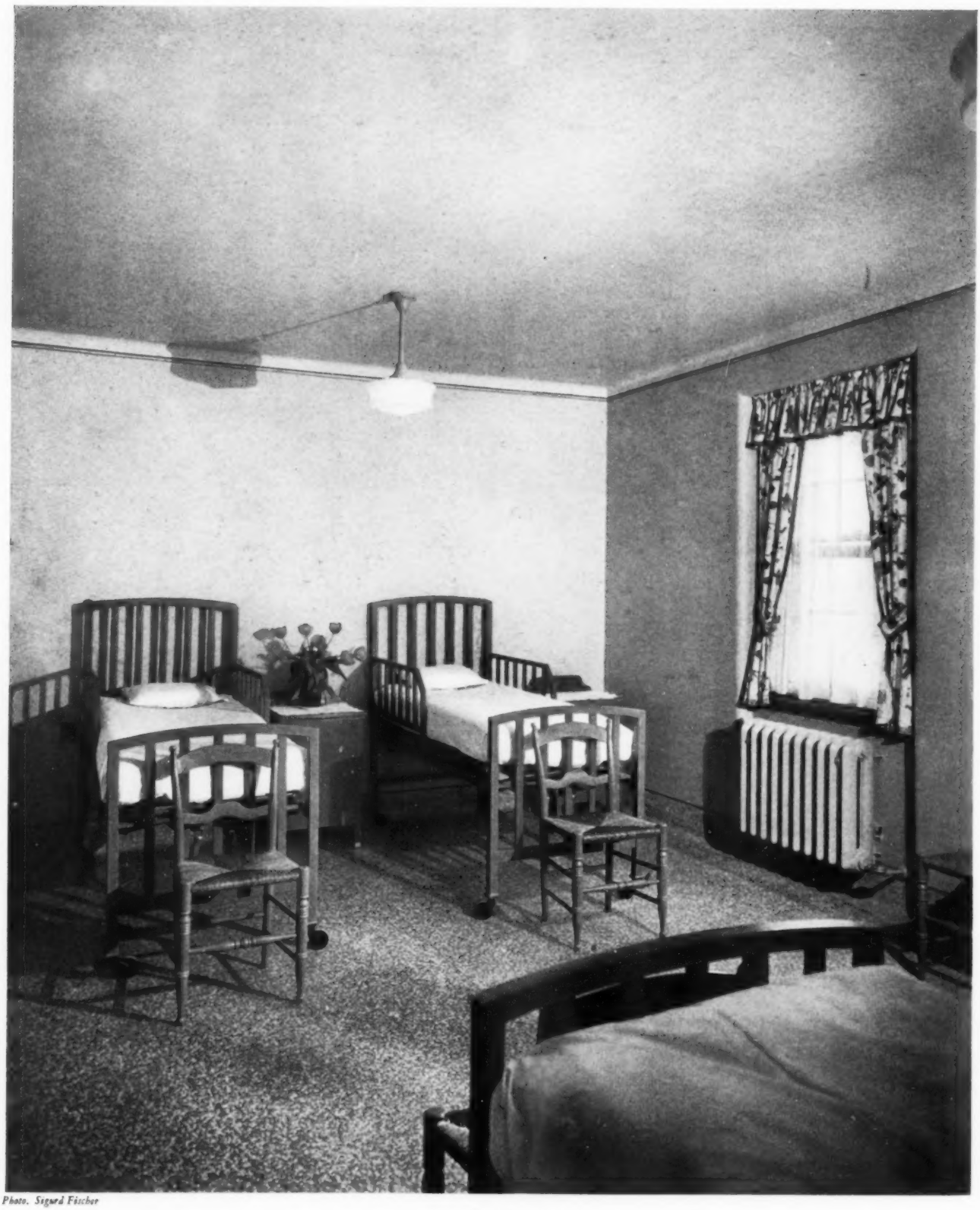


Photo. Sigurd Fischer

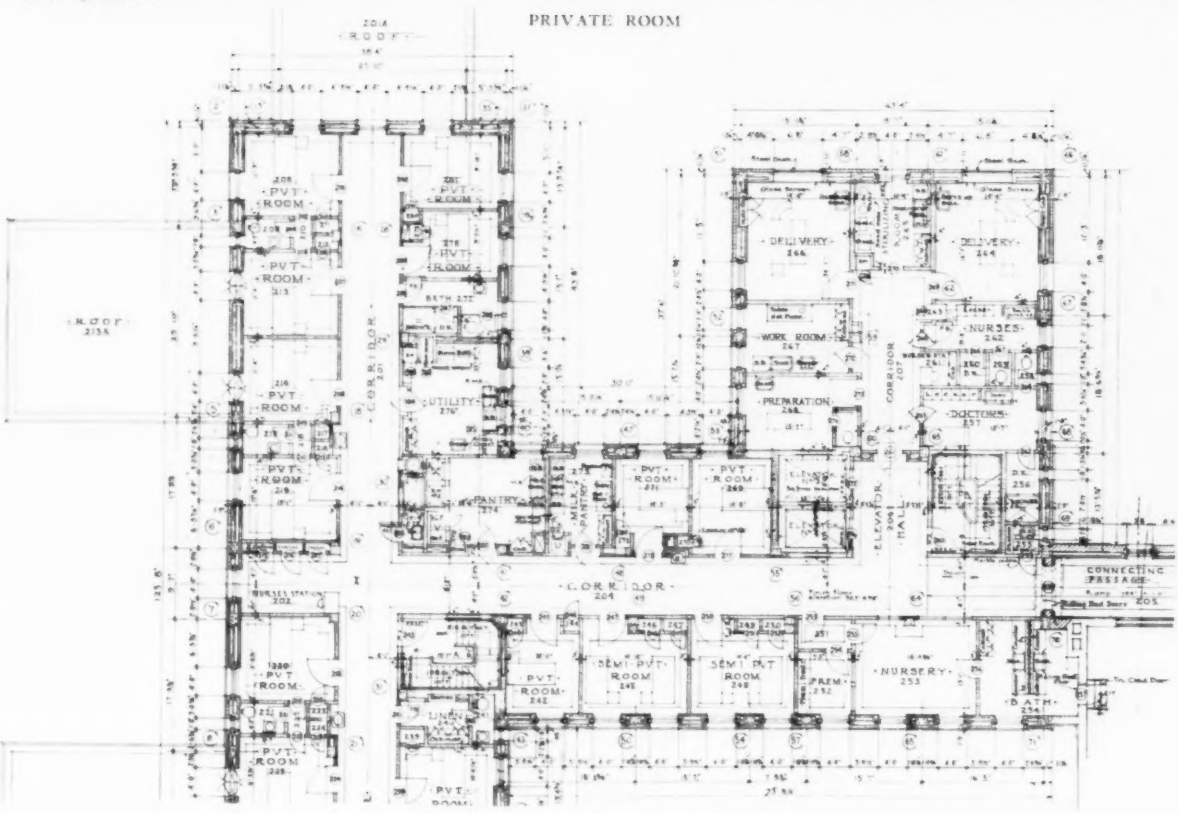
CHILDREN'S WARD

ARNOT OGDEN MEMORIAL HOSPITAL, ELMIRA, N. Y.

YORK AND SAWYER, ARCHITECTS

Photo. Sigurd Fischer

PRIVATE ROOM



SECOND FLOOR PLAN, PAVILION

Photo. Sigurd Fischer

NURSES' DINING ROOM

ARNOT OGDEN MEMORIAL HOSPITAL, ELMIRA, N. Y.

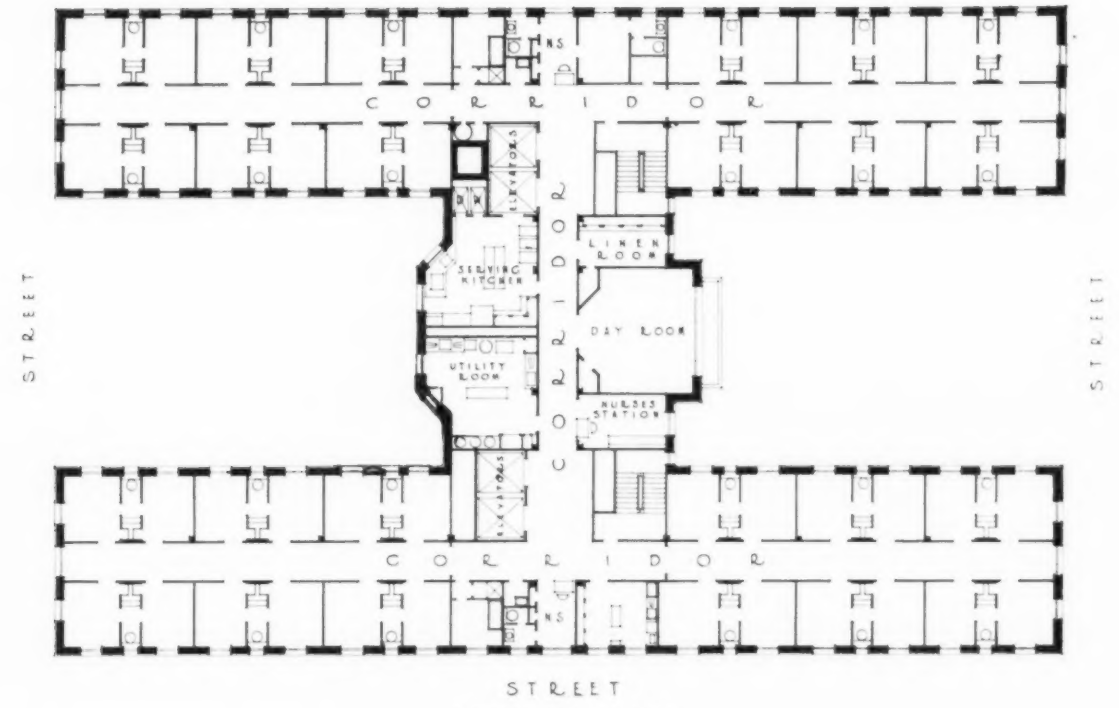
YORK AND SAWYER, ARCHITECTS

Photo. Sigurd Fischer

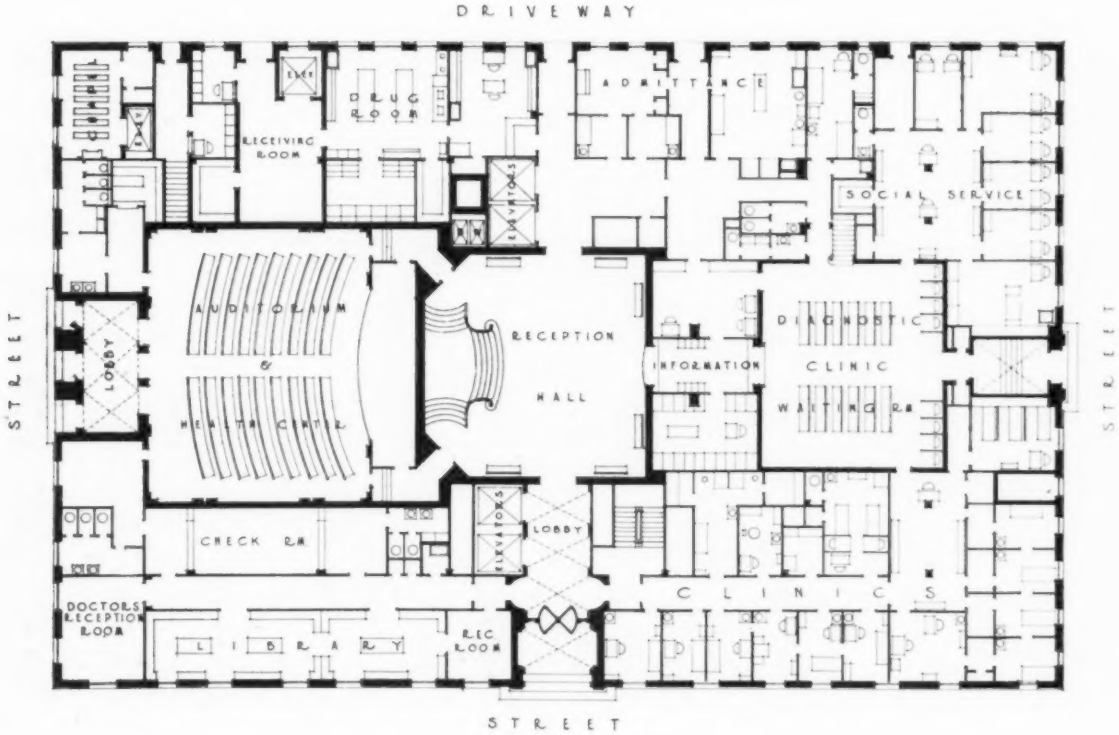
NURSES' STATION

ARNOT OGDEN MEMORIAL HOSPITAL, ELMIRA, N. Y.

YORK AND SAWYER, ARCHITECTS



TYPICAL FLOOR PLAN



FIRST FLOOR PLAN

BETH ISRAEL HOSPITAL, NEW YORK CITY

LOUIS ALLEN ABRAMSON, ARCHITECT

Photo. M. Rosenfeld

BETH ISRAEL HOSPITAL, NEW YORK CITY

LOUIS ALLEN ABRAMSON, ARCHITECT

Photo. M. Rosenbluth

TYPICAL CORRIDOR

BETH ISRAEL HOSPITAL, NEW YORK CITY

LOUIS ALLEN ABRAMSON, ARCHITECT

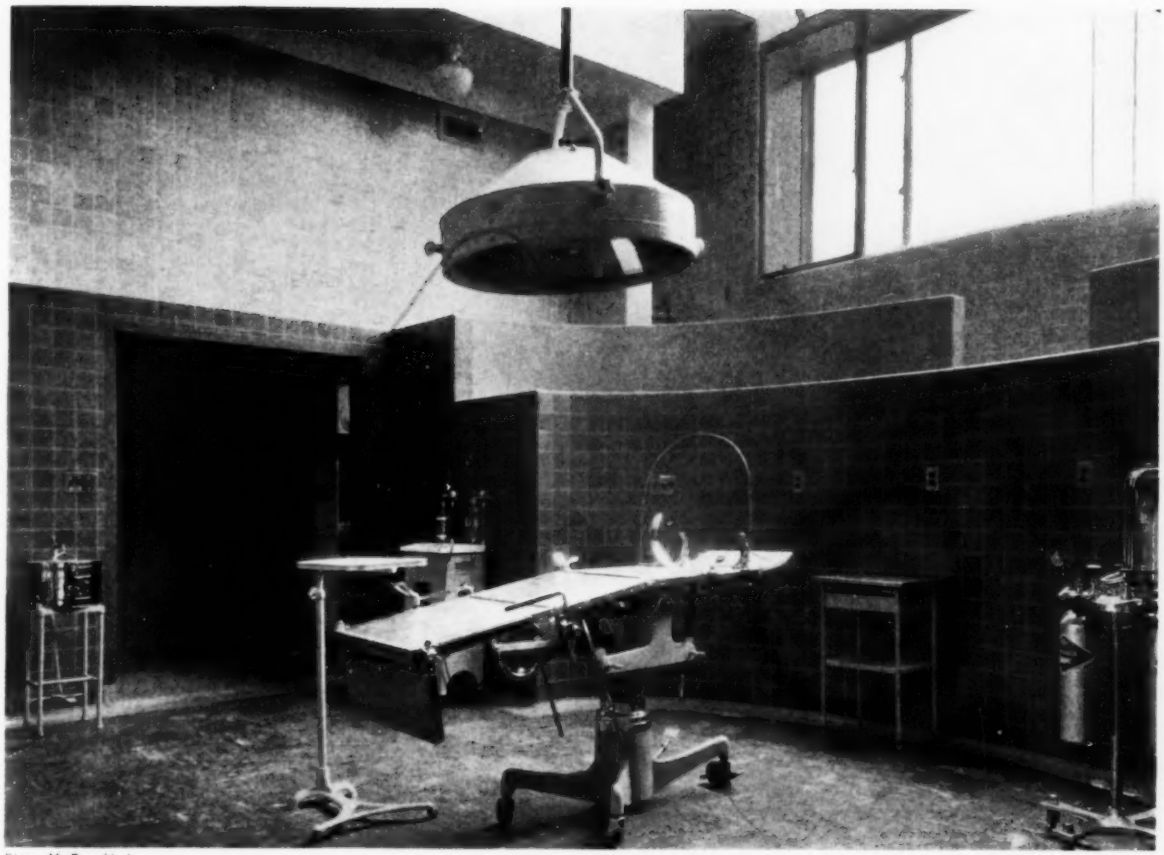
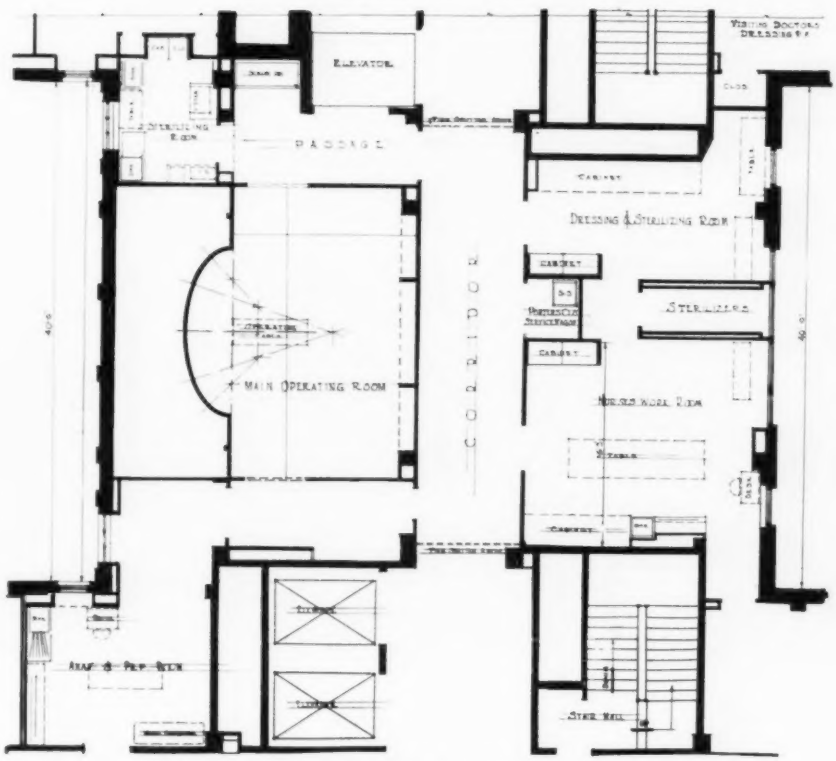


Photo. M. Rosenblatt

MAIN OPERATING ROOM



BETH ISRAEL HOSPITAL, NEW YORK CITY

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Photo. M. Rosenbluth

SYDENHAM HOSPITAL, NEW YORK CITY

CHARLES B. MEYERS, ARCHITECT

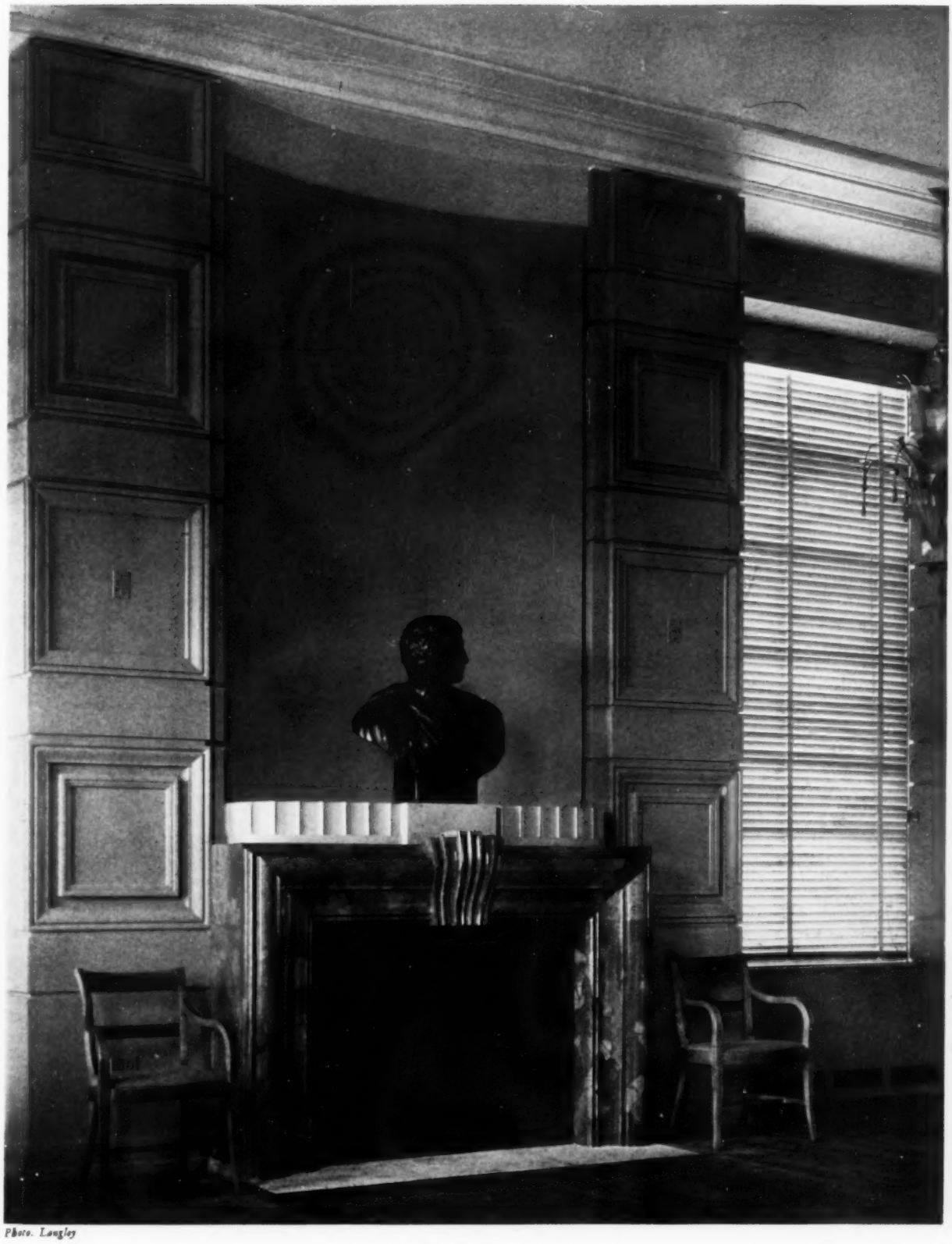

Photo. Langley

THE DANISH ROOM CHIMNEY PIECE

ALTERATIONS IN THE HOTEL ADOLPHUS, DALLAS, TEXAS

RALPH COLE HALL AND VICTOR PROETZ, ARCHITECTS

BRYANT AND SHARP, ASSOCIATE ARCHITECTS

Photo. Langley

THE DANISH ROOM

ALTERATIONS IN THE HOTEL ADOLPHUS, DALLAS, TEXAS

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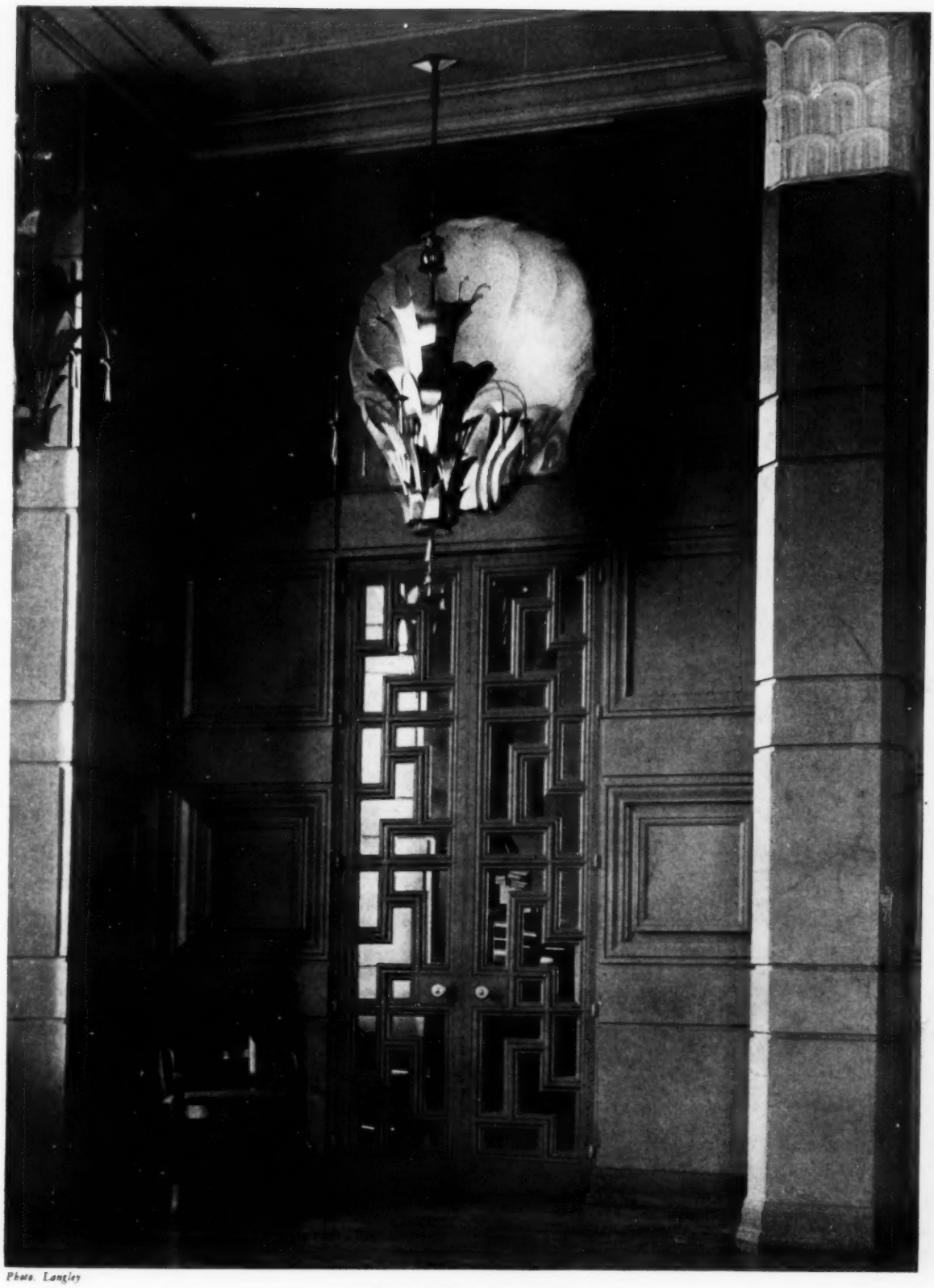


Photo. Langley

THE DANISH ROOM DOORS

ALTERATIONS IN THE HOTEL ADOLPHUS, DALLAS, TEXAS

RALPH COLE HALL AND VICTOR PROETZ, ARCHITECTS

BRYANT AND SHARP, ASSOCIATE ARCHITECTS

Photo. Langley

THE WHITE ROOM, DOORS INTO THE YELLOW ROOM

ALTERATIONS IN THE HOTEL ADOLPHUS, DALLAS, TEXAS

RALPH COLE HALL AND VICTOR PROETZ, ARCHITECTS

BRYANT AND SHARP, ASSOCIATE ARCHITECTS

THE DEMONSTRATION HEALTH-HOUSE, LOS ANGELES

RICHARD J. NEUTRA, ARCHITECT

THE ARCHITECTURAL PROBLEM

The building was to serve as the home of a very sociable family with educational interests and an active preference for the out-of-doors. A non-profit-making experimental open-air school was attached to the residential building program.

A southern hillside was chosen, located in the immediate vicinity of a huge mountainous municipal park-reserve and commanding a magnificent view of the distant ocean.

•

PROFESSIONAL SERVICE

In order to make all elements of the conception effective (since in experimental work everything depends on the minutest detail), all planning, designing, structural and architectural drafting, all the detailing of built-in equipment and furniture, the landscaping, the supervision, and even a continuous book survey—were handled by the architect.

•

CONSTRUCTION

A light-weight steel frame of standard sections was erected on a unit plan, the divisions of which accorded with the size of the selected stock steel casements (see plans), with their standardized cross-sections and spandrel-beam lengths. All the numerous porches and balconies were suspended from the roof level, in order to avoid the scattering of depth requiring cantilever construction on the different floor levels. Supporting balcony brackets were excluded because their side thrusts would produce undesirable bending moments in the slender steel posts. All spandrel-to-column connections are stiffened by 12″ wingplates to secure further earthquake resistance. Joists are bar trusses electrically welded. All outside walls are of 3.6″ expanded metal reinforcing with $1\frac{1}{4}$″ of dense concrete shot from an air-compression gun. All inside partitions are of metal lath and plaster.

Foundations, retaining walls, and the framework of the suspended swimming tank are of reinforced concrete. Walls of the handball courts and the open-air theatre have structural pipe construction with reinforced shot concrete as described above.

•

EQUIPMENT

Comprehensive sprinkling system for roof and balcony flower-containers and over the whole estate, with concentrated control in the patio. Gas-fired incinerator with hopper door on drain-board. Revolving cooler; electric dishwasher and kitchen aids. Housephones and annunciator system; four dynamic loudspeakers with remote control. Electrically controlled hot-air system, with cold-air return. Electric heaters. Hydraulically controlled overhead garage doors. Gasoline tank and pump, capacity 280 gallons. Inset ceiling lights; indirect lighting of living quarters.

Plate glass, ultra-violet-ray glass; opaque-glass wainscots; glass and tile floors; heavy linoleum; broadloom carpet in downstairs living room and study. Walls covered with washable canvas. All hardware and metal parts chromium nickel. Two long one-piece drainboards in shop-cast "petrium"; Bakelite tops for kitchen and other tables.

•

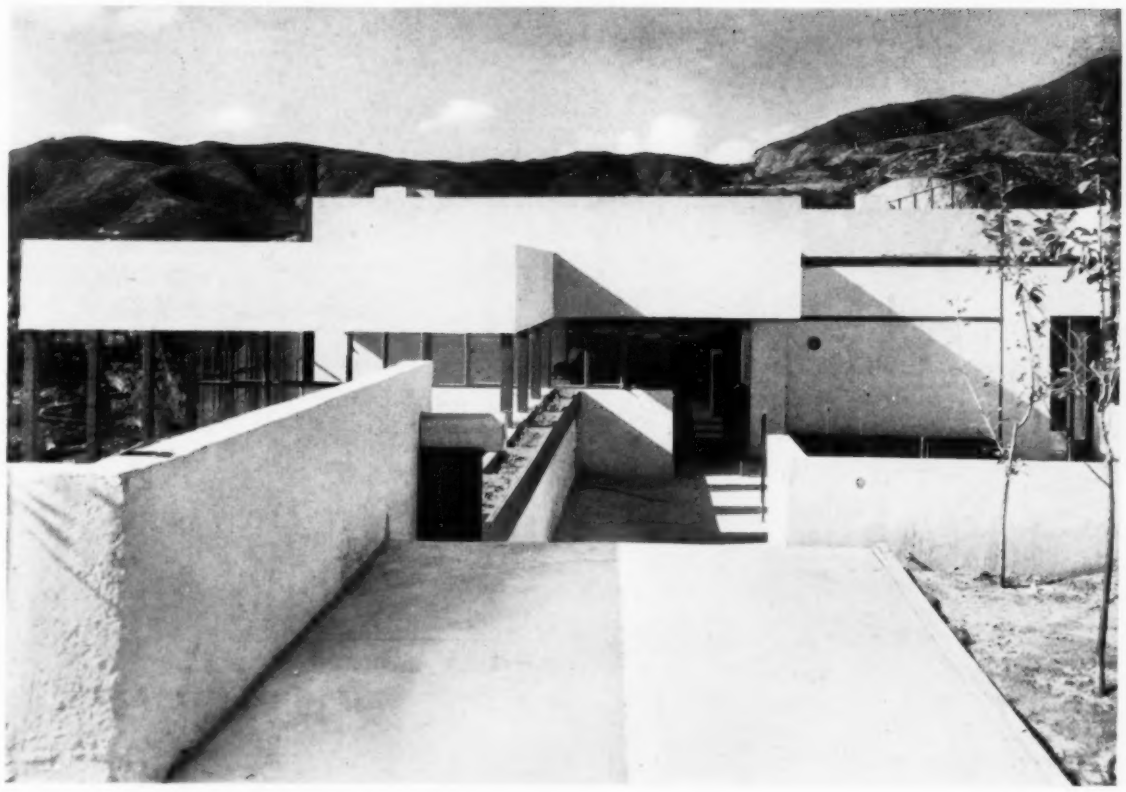
COLOR

Exterior nearly white; exposed steel, battleship gray. Planting in balcony containers, at pergolas and on grounds adjoining the building, in tones of pale blue and purple, with nearly permanent blooming: *Ceanotus spinosus*, *Plaumbago capensis*, *Bougainvillea crimson-lake*. Yellow flowering shrubs and trees framing the blue distant view of the ocean: varieties of *Accacia*, *Cassia*, *Genista*.

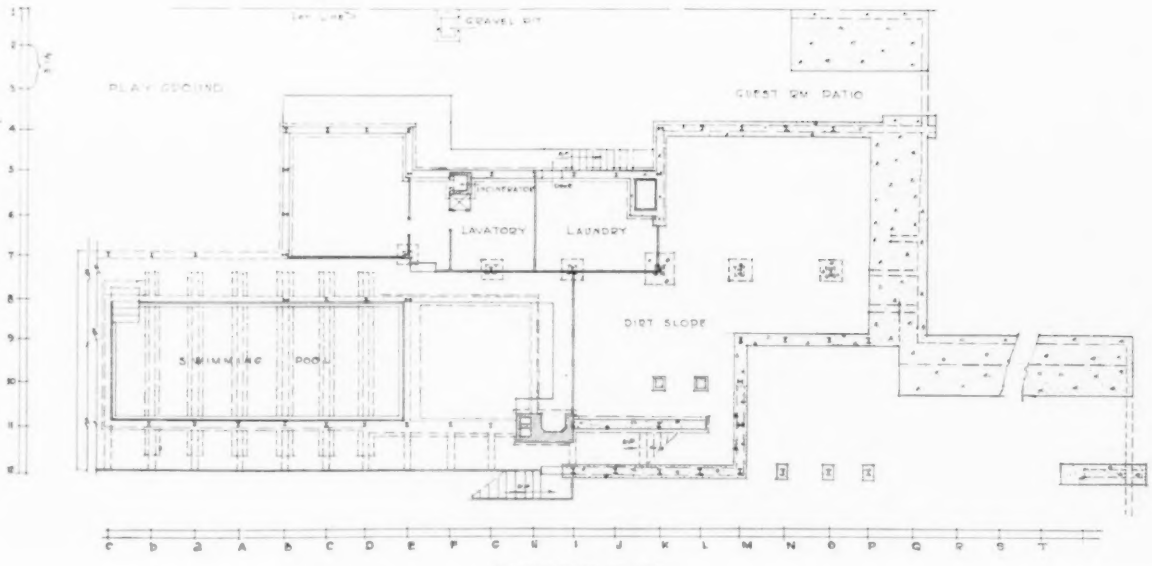
DETAIL VIEW FROM WEST SIDE

DEMONSTRATION HEALTH-HOUSE FOR DR. PHILIP LOVELL, LOS ANGELES

RICHARD J. NEUTRA, ARCHITECT



MAIN ENTRANCE



BASEMENT PLAN

DEMONSTRATION HEALTH-HOUSE FOR DR. PHILIP LOVELL, LOS ANGELES

RICHARD NEUTRA, ARCHITECT

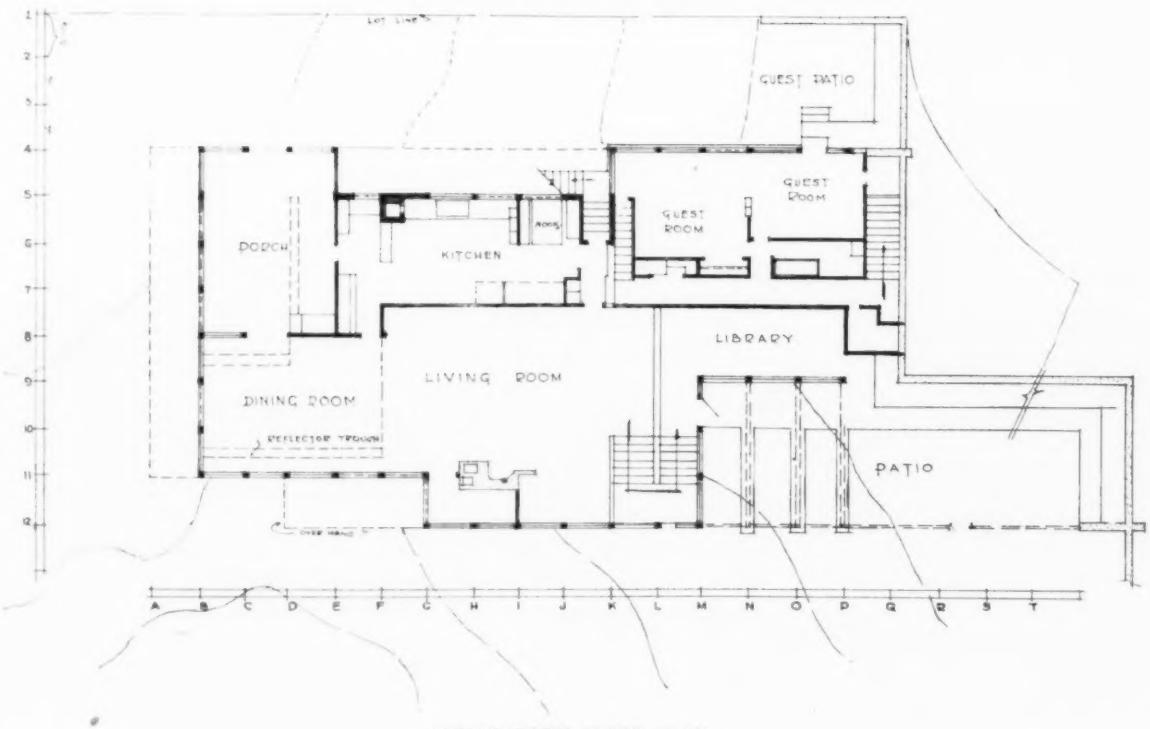
VIEW FROM SOUTH

VIEW FROM SOUTH WEST

DEMONSTRATION HEALTH-HOUSE FOR DR. PHILIP LOVELL, LOS ANGELES

RICHARD NEUTRA, ARCHITECT

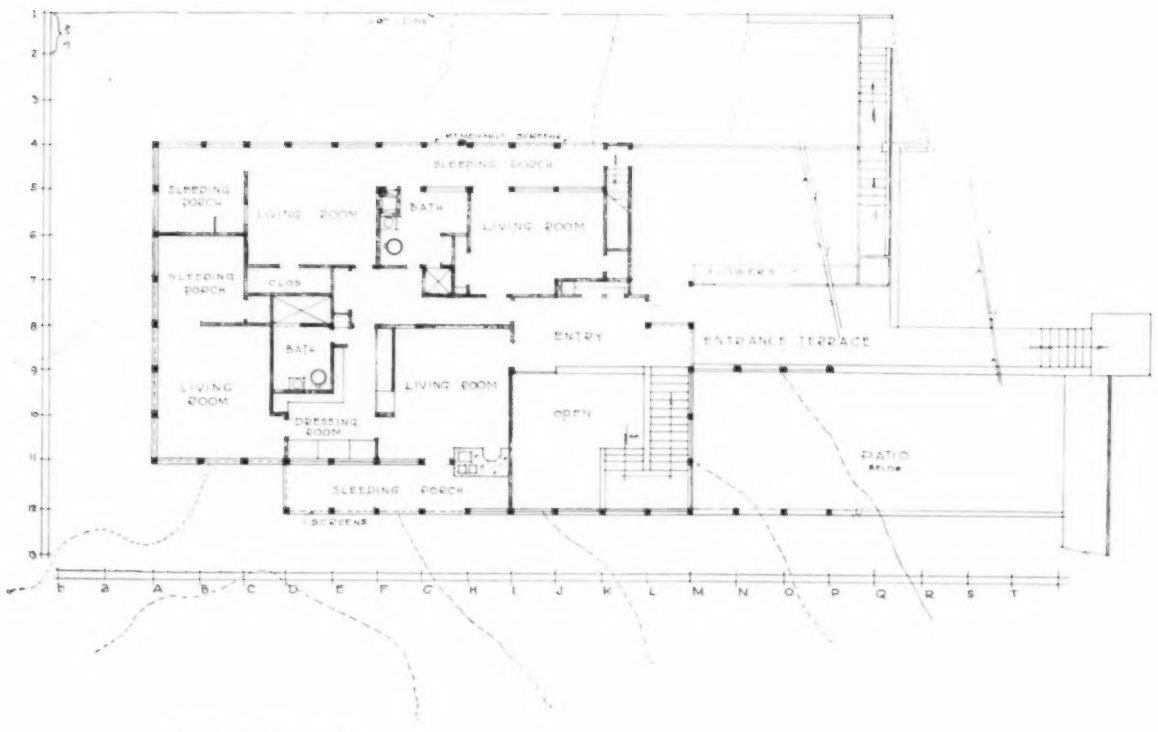
BED-ROOM AND PRIVATE OFFICE



LIVING-ROOM FLOOR PLAN

DEMONSTRATION HEALTH-HOUSE FOR DR. PHILIP LOVELL, LOS ANGELES

RICHARD J. NEUTRA, ARCHITECT



THIRD FLOOR PLAN

INTERIOR COLOR SCHEME

In downstairs living quarters: silver-gray carpets; wood furniture in dark gray lacquer; metal furniture chrome nickel. Hangings plain cobalt blue; flat goat-hair fabrics.

Upstairs living quarters: aluminum lacquer, bright yellow hangings, light gray plain linoleum. Bath and kitchen, light gray enamel and white opaque-glass wainscots. White vitrified tile and glass floors.

At Right: DESK AND DRESSING TABLE

DEMONSTRATION HEALTH-HOUSE, LOS ANGELES

RICHARD J. NEUTRA, ARCHITECT

BATH ROOM

DEMONSTRATION HEALTH-HOUSE FOR DR. PHILIP LOVELL, LOS ANGELES

RICHARD NEUTRA, ARCHITECT

A DESIGN FOR A FILM SET OF THE FUTURE
BY E. CARRICK

MOVING PICTURE SETS—

A Medium for the Architect

BY EDWARD CARRICK

Many architects whom I have met think there is no art in the films, and then it turns out that they go to see about five films a year and generally strike "dud" performances. An architect who has seen films such as *Doctor Caligari*, *The Student of Prague*, *The Thief of Bagdad*, *A Woman of Paris*, *Siegfried*, *Metropolis*, *Ten Days That Shook the World*, *The Fall of St. Petersburg*, and *Potemkin*, cannot but admit that the moving picture is perhaps one of the greatest mediums for expression that has yet been used. In some films the art direction rests wholly in the building and lighting of a door, a window, or the corner of a street. In others, like *Metropolis*, and *Secrets of the East*, the art director has just given flight to his imagination: the first picture showing a world of the future, and the second a world of the imaginary past. It was by the simplest of devices and minimum expense that scenes such as those in *Metropolis* were made.

"Art Director" is the name generally given to him who designs, furnishes, decorates and arranges the scenes or backgrounds of a film in harmony with the general characteristics of the drama which is being represented, so that its atmosphere and artistic qualities help the action to register sentiments among the audience. One day the art director and producer will be one and the same person. At present, in most countries, they are two people, and as the producer comes first, the art director has to help to express the producer's ideas or give him ideas to express. In Germany, well-known artists such as Klaus Richter are art directors, and when they make designs for scenes they show the action taking place in them and sometimes also make details of the action.

When a scene is set it is the art director who arranges the folds of the curtains, who places the bowl of flowers, or arranges an ink stand, so that when the critical moment comes for a "close-up" these simple things become of intense atmospheric value.

The departments in a film studio that come under his command are the following: carpentry and joinery, plasterwork, model-making (a very important branch and often overlooked), furniture and properties, decorating, trickwork and sometimes costume designing, but that seldom, except when historical accuracy is required. His materi-

FROM A CAVALCANTI'S PRODUCTION "EN RADE"

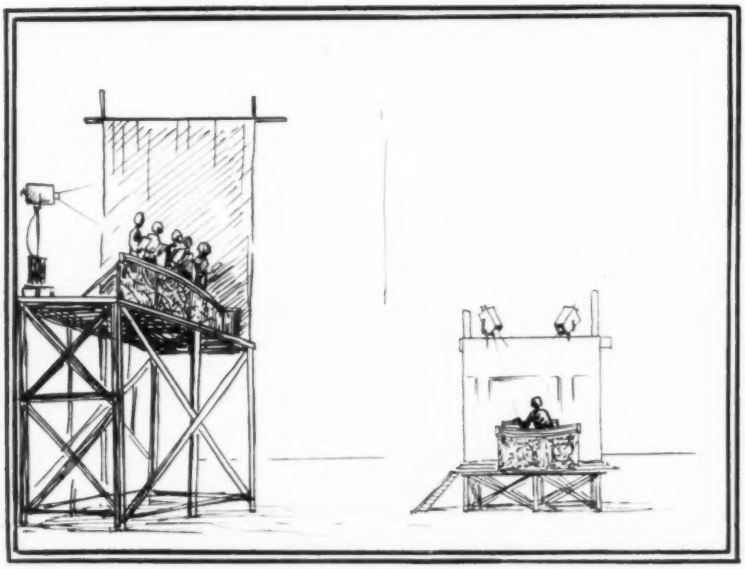
A scene by the French artist Eric Ars. Here it will be noticed how innumerable little subtleties go to make a dramatic picture.

als can be anything he chooses; but those used in the chief European studios are plywood, planks and all sized timbers, wire netting, sackcloth, plaster, sawdust, paper, paint, and all the usual wood mouldings. In Germany the plaster shops are brought to great perfection and they think nothing of taking moulds of Italian 16th century carved panelling and casting the whole thing in plaster.

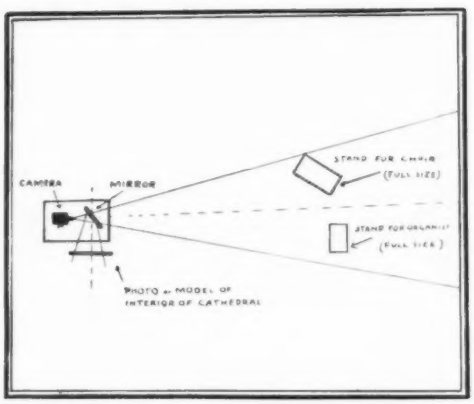
Perhaps the most interesting and exciting work that is handled by the art director and in which architects of imagination would shine is what is known as process work. There have been many kinds of "processes" used in the past, such as the *glass process* and the *model process*, but they have all been defective; whereas now the Germans have patented a new method, the *Schufftan Process*, which is the cleverest little invention going, for it permits one to build the streets of Babylon, or one of Piranesi's prisons, at little more than the cost of the materials in an ordinary drawing-room set.

The Schufftan process, because of its simplicity and ingenuity, is really worth describing. If, for example, you wanted to represent the celebrated episode of Benvenuto Cellini escaping over the battlements of the Castle of St. Angelo in Rome, you would then make a very perfectly detailed model, or get a perfect photograph, of the castle of St. Angelo. This model you light realistically, and if you like you can have cloud effects achieved by means of smoke or a projector. The whole thing you reflect in a sheet of looking-glass at a

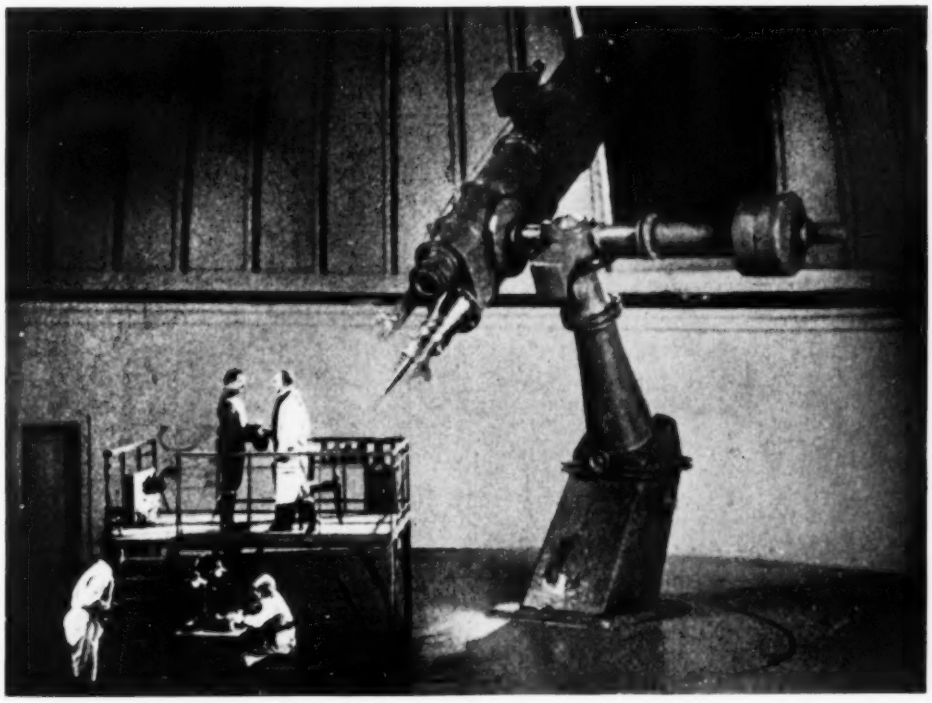
A rather unusual shot of a cathedral choir in which the Schufftan Process has been used. A photograph of the actual cathedral was made and reflected into the mirror and at the parts where the choir and organist are seen the mirror was scraped away and two platforms were built at a distance behind the mirror to take them, thus filling the spaces.



All that was actually built for the cathedral choir set

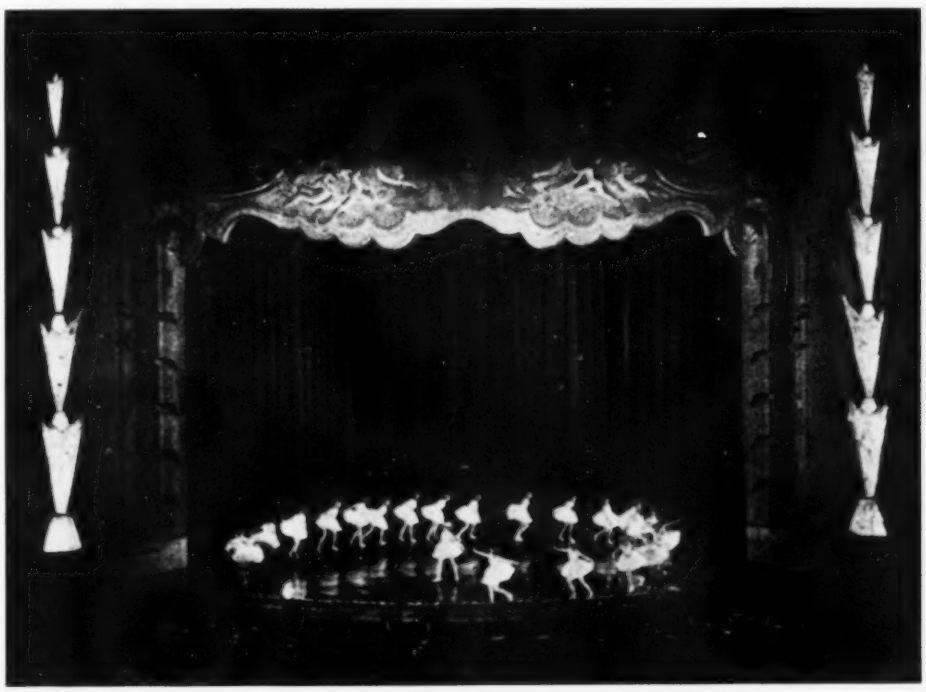


Plan showing positions of camera, mirror, photograph and platforms



A SCHUFFTAN PROCESS SET

Only the rostrum where people are standing is real, the remainder is all model. For the telescope an ordinary 12-inch microscope was used.



Stage, proscenium and orchestra are Schufftan Process. Only the floor space where the ballet is in progress is real

THE HALL SCENE IN "YVETTE"
DESIGNED BY ERIC ARS FOR A. CAVALCANTI

certain angle in front of the camera, so that looking through the view-finder you get a perfect picture of the model in the mirror without the reflection of the camera. Now for the action. You want Benvenuto to throw a rope over one of the battlements and climb down; so you go behind your glass and scrape away the silver right down the wall where the figure should pass, then looking through the camera again at your reflected castle you find that you have an oblong hole in the wall through which you can see into the space beyond.

Then, at a given distance behind your mirror, the distance being governed by the laws of perspective, you build a tall strip of battlement, life size, and paint and light it so as to correspond with the model in tone. The action begins; Benvenuto throws over the rope and clambers down the battlements of the castle; and the only expense has been a tall strip of wall and a small model!

"But you see the join," cries the old-fashioned art director, but you don't; and that is why the German idea is so clever; for, as they explain, all things reflected in a mirror are infinite, and therefore are in focus, whereas the jagged sawlike edge where the silver has been scraped away, because it is so near the camera, goes out of focus and disappears into the reality which is built at the correct perspective distance. This is an extraordinarily interesting process for the art director to work with.

The day when a few more architects with imagination and initiative come into the films we may expect to see some marvels of construction come to life and the films, let us hope, profit by it.

ARCHITECTURAL EDUCATION AGAIN

THE architectural schools face a difficult situation today. Within the last twelve months—it is really hardly more than that—the position of those who have supported purely traditional training in the art has become unbearable. All but a few schools have been forced to come to some terms or other with a contemporary style—or contemporary "styles"—of architecture. Those terms seem to be that contemporary design, whether as "style," or as "styles," is admitted on a par with the "styles" of the past which since the foundation of our schools have been favored for resurrection. This is quite a logical position for the schools to take, however unhealthy it may be for the development of a new generation of truly contemporary architects.

It is argued that architects depend, much more than painters or composers or poets, on patronage; that they must be ready like the inspirates of Hollywood to provide what the public (supposedly) wants. The schools are vocational schools, or at least professional schools. They must provide the public with men trained to attend to their architectural wants, as law schools train lawyers. It would, it is certainly honest to argue, not be fulfilling their purpose if today in America they turned out architects incapable of producing Georgian houses and Gothic churches and Paris-Exposition-of-1925 shop fronts, since these are all still so definitely in demand.

Architects leaving the schools must usually pass some years of apprenticeship in large offices before they set up for themselves, and the field would be very limited for them if they were trained purely in contemporary design—or indeed purely in contemporary construction—with no knowledge of wood and traditional masonry methods. I think one may still remain a radical idealist, a fire-eating modernist, and a rabid anti-traditionalist, and yet accept the above argument. But one can have little optimism respecting the possibilities of the contemporary style, and less intuitive understanding of it, if it is true that contemporary training in design, thus given on a par with training in reminiscent design, is likely to be either very sound or very profitable. Modern architecture cannot be served by syncretist acceptance. Either it is a new way of light which demands conversion, or it is merely an impediment in the growth of taste in revivalism. This is indeed an *impasse* not restricted to this country and the situation is as precarious in the *Ecolé des Beaux-Arts* in Paris as in the most advanced architectural schools here.

There is one method that one finds extensively employed by young men desirous of becoming modern architects in Europe. A significant return to the full apprenticeship system is going on—so significant that if one wishes to know what way the student generation is turning it is necessary to seek out its members in the offices of the great contemporary architects. Apprenticeship has its advantages and, of course, it has never entirely been given up in architectural education. But with the complexities of modern construction, the scale of American architectural offices, and the increasing importance of design in the most fundamental sense, it has serious faults. Apprenticeship is best adapted to the study of a craft-art, and modern architecture for better or worse can clearly no longer hope to be, except in very exceptional instances, a craft-art.

In Europe there are also new architectural schools founded since the newest architecture developed. Two of these are of great importance, that of the *Bauhaus* at Dessau founded by Walter Gropius, and that of the *Institut Superieur des Arts Decoratifs* at Brussels of which Henry Van de Velde is the head. In these schools, and doubtless in others as well, the young man or woman who has decided to become not simply an architect but a contemporary architect, can receive a complete course of instruction into which the hypothesis of imitation of the past never once enters. City planning and the functional study of industrial architecture receive special emphasis, and design is based absolutely on contemporary means of production. At the same time, as is seldom the case in America, the students are brought definitely into connection, by subsidiary or volitional courses, with contemporary painting, sculpture, theatre arts, publicity, music, and literature. They are also in direct association—like the students at the American Academy in Rome, but to how different a purpose!—with students in the other arts, and thus achieve some of that centrality of position which architects have many times needed in the past. That this sort of school will develop, is perhaps already developing, a new academicism, I do not deny. Any institution will develop academicism, and one need not be an anarchist to remark that against any sort of training the hopeful student must needs develop some degree of revolt. Yet there are *anima naturalifer academica*, and for them at the moment it is surely healthier that their academicism should be of the present than of the past.

Since the established architectural schools in America, for reasons already outlined, can hardly become whole-heartedly modern, even leaving aside the question of inertia and the conservatism of trustees, it would appear that we needed in America, for the increasing number of young men desirous of becoming modern architects, new architectural schools along the lines of those in Dessau and Brussels. If such be not provided we may expect to lose to Europe in this generation as many of our best students as we lost a generation ago, when the popularity of the *Ecole des Beaux-Arts* was at its height.

Neutra is teaching in Los Angeles, Lönberg-Holm was for a time at the University of Michigan, Oud is to be at Princeton this Spring: there is no longer any question that instruction by the most advanced architects is welcomed in educational institutions. And yet I do not know, unless it be at Los Angeles, of a single thoroughgoing modern architectural school in the country. Needless to say, I should be only too delighted to be contradicted, for I write without research. Even if such exist, however, we shall need many more than we have, at least for a decade or so until the time comes when all architectural schools in the country may with safety and propriety be remodelled in their likeness.

HENRY-RUSSELL HITCHCOCK, JR.

SOME A, B, C'S OF THEATRE ARCHITECTURE

BY LEE SIMONSON

Although New York has more theatres per capita than any other theatrical capital, probably not a single one is of any importance as an architectural design. With a few possible exceptions the same holds true of theatres throughout the country. Fifty-five theatres were built in New York between 1905 and 1925 and until the movies began to take them over seventy-five were devoted to so-called legitimate theatrical productions. They represented a succession of gaudily ornate auditoriums and stages inadequately equipped for shifting scenery or lighting a play.

American architects have on the whole contributed nothing to the development of the modern playhouse. Compared to the Künstler Theatre at Munich (1908), the Volksbuhne in Berlin (1914), the National Theatre in Prague, and the State Theatre of Stuttgart, not to mention a half dozen more provincial playhouses, the best work in America is negligible.

Be it said at the outset that American architects are not to blame. Until very recently any architect interested in a theatre design in this country had no clients who were in the least interested in building better theatres. In Europe playhouses are as important in the eyes of a community as Mecca and Masonic Temples are to us. In European capitals, theatres have been considered civic monuments as public libraries are here, and before the war every city of importance aspired to have one on an imposing site. But almost all our theatres have, until recently, been built for real estate speculators or theatrical landlords whose one interest has been to sell the site value of the plot for as high an annual rental as could be exacted, giving as little in return as possible.

Theatre architecture has been debased because it has been in the service of the organized speculation on which the theatre business is founded in this country. No consideration of the problem of theatre building can ignore this organized speculation which dignifies itself as the 'show business.' A production with a single small set, a small crew of stage hands to operate it, and not too large a cast in modern clothes (some of which the actors furnish), can often be staged even with rehearsals for no more than twelve thousand dollars. More elaborate productions, with changes of sets and period costumes, rarely cost more than thirty-five thousand dollars. (These figures are for 'dramatic productions.' Musical comedy costs are higher but they are compensated by a higher scale at the box office and a greater weekly intake if successful.) Anyone who can lay his hands on twenty to thirty thousand dollars of capital can stage a play and in addition to our so-called 'regular managers' people with almost no experience do so. The incentive is the fabulous profit to be made if a play proves to be a 'hit' or a 'smash hit.'

Journey's End in it first year's run in New York of 401 performances did a box office gross of $819,873.48; 222 performances in Chicago grossed $348,367.65. The total box office intake of the play, including three road companies, for the United States, was $1,727,157.68 during the first year. In England the receipts of the London company and three road companies in approximately fourteen months was $920,000. The world's receipts since this play's premiere, January 21, 1929, have been $1,997,157.68. Add to this another year's run in theatres all over the world and world talkie rights as well, and the ultimate gross intake of this single play within three years of its opening may very well amount to between four and five million dollars.

A success of this sort out of the hundreds of annual theatrical productions is of course a hundred-to-one chance. But it is just that hundred-to-one chance to which the entire business of theatrical production is geared. It is the secret hope of everyone to find a *Journey's End*, a *Lightning*, or an *Abie's Irish Rose*, which will amass a fortune just as *Ben Hur*, *Monte Christo*, and *The Old Homestead*, did in a previous generation.

The theatre owner and theatre landlord have a stake in these profits. Theatres are hired on the business basis of giving forty per cent of the gross box office receipts to the theatre owner. If the theatre's share falls below five or six thousand dollars a week, a provision that is usual in every contract requires the tenant to vacate, and a new attraction is "booked." But on even less phenomenal successes than *Journey's End*, on which the average of the forty weeks of a theatrical season may easily be $14,000 a week, the theatre owner, even if his theatre is vacant for June, July, and August, may take in nearly a quarter of a million dollars.

The average theatre, seating from a thousand to twelve hundred people, can usually be built at a cost of from $600,000 to $1,000,000, depending upon its site value. What other form of real estate offers the opportunity of a gross return in any one year of twenty-five to nearly fifty per cent of the capital invested?

The theatre owner and producer moreover are often one and the same person. A producer who is also a theatre owner and controls a few theatres either outright or on yearly lease can, even in a

season when his own productions are failures, make a handsome profit by letting or sub-letting his theatres to the successful productions of his rivals.

For this reason a theatrical center in New York roughly a mile long and half a mile wide has been jammed with theatres often six or more to a single cross-street. The owner's policy is to crowd as many seats with as narrow aisles as the fire law will permit, into a 100 x 100 plot, reduce lobby space to a minimum, and give the stage the smallest proportion of the plot possible. Not only is the stage cramped to the utmost but it is equipped with a minimum of rigging necessary to make speedy scene shifts. Many stages in New York are so shallow that a play with four or five settings cannot use them. The switchboard provided by the theatre is often only large enough to control the lighting of the auditorium. Every play must bring in its own lighting equipment, dimmers, and lamps, together with every foot of cable needed. So definitely are most theatres planned for tenants that many do not provide even a single office for the management. But an extra thousand or two for rehearsals, an extra thousand or two to light a production adequately—what do they amount to when one is playing for the stake of half a million a year? Anything will do as long as one can get an auditorium with a prospect of selling it out, for such is the magic of a 'smash hit' that the public will fight to get in, crawl over each other's knees, endure a subway crush at the entrance and during the intermissions, and accept seats so spread to one side or the other that a third of the stage is invisible.

II.

What architectural progress could be expected under such conditions? Such theatre architecture as we have had reflects this economic heyday of the show business which continued until four or five years ago. But that heyday is over.

The increasing costs of railroading, of salaries, and of union labor, and again the ubiquitous movies and talkies outside of the big cities, have so depleted road profits that a road tour even of a substantial success is now the exception rather than the rule. For the first time in a decade theatres in New York have stood empty months at a time. Very few if any will again be built by the old-time real estate speculator and none, it is safe to say, will be built upon the road. The 'big money' is going into movie palaces where the great speculative returns can be earned in the future.

But theatre architecture is likely to emerge much the better for this depression which lately has approached the proportions of a panic, for, out of the shambles of the 'show business,' a new type of management has begun to emerge. These managements are not speculators raking together enough capital in order to make half a million dollars a year at one throw. They undertake theatrical production on a more coherent and continental basis. They are content with profits far more modest. They produce on a year-round program with a permanent company of actors, and by sustaining a standard both of material and production rely on the good will of a permanent audience that returns regularly for successive bills, like the *abonnés* of theatres abroad. They need a technically efficient plant and a well-equipped stage, for they realize that bad planning and clumsy mechanics, as in any other form of production, are paid for by needlessly increased overhead expense.

The Neighborhood Playhouse, the Cleveland Playhouse, the Civic Repertory Theatre, and the Theatre Guild, among others, are typical of these newer types of producing organizations. When their endowment or their earnings enable them to erect a theatre the problem they present to the architect is not, "How little can we get away with or how much can we charge the other fellow," but, "What is the best type of theatre to build in order to produce plays well?"

III.

A certain number of American architects will do well to familiarize themselves with the problem, for the bulk of tomorrow's theatres will be built not only for this newer type of professional producer but for amateurs as well.

As a result of Professor Baker's epoch-making experiments at Harvard twenty-five years ago, courses in playwriting and play production are becoming a recognized part of every university curriculum. A well equipped theatre, as at Yale, will presently be as much a part of every university campus as chemical laboratories or lecture halls are today. From the universities the demand has seeped into the high schools and from there into the grammar grades. Instruction in the art of the theatre is becoming general. Even high school auditoriums begin to be scaled and equipped today not only for commencement exercises and the morning assembly but for regular theatrical performances as well.*

Community playhouses with amateurs increasingly proficient provide a substitute for the defunct local stock company and for the dwindling number of Broadway productions on tour; and civic centers include stages ample to house not only their own efforts but to lure professionals from nearby cities. It is typical that the Westchester Community Centre just before its completion was remodeled to include a well equipped small stage for the amateur group and a large one adequate to house visiting companies.

*For the astonishing growth of community, university, and smaller theatres, see Kenneth Macgowan's "Footlights Across America," Harcourt Brace, 1929.

These are the theatre architect's new clients who make it imperative for him to face a few essentials of theatre design. I shall attempt to outline them in a preliminary way for professional stages, ignoring the modifications that may be involved in designing for college theatres, community theatres, amateur groups or high schools.

IV.

SIZE OF THE STAGE

A theatre is not only an auditorium where people sit and see a play but a stage where plays are produced. It involves the very necessary space where the work of putting on a play has to be done. Unless there is to be a shameful waste of time and labor, the stage cannot be constricted below a certain minimum of space. To perform a play there must be enough mechanical equipment to shift settings speedily, and to light them effectively once they are set.

In this connection it is essential to realize that the stage opening seen from the auditorium, in proportion to the total size of the stage or stage-house, is no more than that of a shutter at the bottom of a long chute. (See diagram) And for this

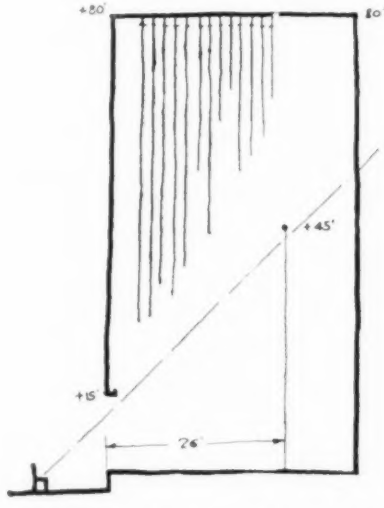


DIAGRAM OF A STAGE HOUSE

Showing dimensions necessary for good working room. "The opening seen from the auditorium is no more than a shutter at the bottom of a long chute." See text above and below.

reason: the stage is not only a space where a setting may be seen but a space where the other settings not in use must be stored while the particular one is being played in. Because the audience looks up into a stage, settings not in use must be hauled up out of sight. When the curtain is up approximately fifteen feet, a background set twenty-six feet back must be forty to forty-five feet high if a spectator is not to look over the top of it. For that reason the stage-house should be a minimum of sixty-five feet high, and where possible eighty and eighty-five feet, particularly if scenes are occasionally to be played to a depth of thirty feet or more.

Due to the cost of sending up brick or concrete walls to this height, this is usually the first item sacrificed in order to cut down the total budget. But any compromise here is invariably fatal because it involves added labor in running a show, cramps freedom of design, destroys the beauty of innumerable stage pictures, blocks the proper planning and use of lighting equipment, and slows up scene shifts.

Settings must be broken in pieces to be handled, then lowered or hauled on stage, and lashed together. Smaller sections are rolled or carried off to one side when a scene is shifted (struck), large sections hauled up out of sight. Each piece of scenery is attached to a metal pipe (batten) from which the lines run over pulleys (shives) to a slotted flooring (gridiron) at the top of the stage-house. (Page 477.) These lines are then carried down to the stage floor, tied off to a pinrail, and balanced by counterweights that can be adjusted to the weight of any particular piece of scenery, thus reducing the deadweight to be hauled. Sets of lines are usually placed six inches apart so that any piece of scenery can be hung over the position on the stage where it has to be set, and the number of such sets of lines should run from a minimum of fifty to a maximum of seventy or eighty, depending on the depth of the stage. Fortunately the gridiron, with its lines, battens, pinrail, and counterweights, has been standardized and can be easily installed provided the architect has taken the precaution to provide at least sixty-five feet at the gridiron level and keeps one side of the stage wall free for the pinrail, unbroken if possible by doors and entrances.

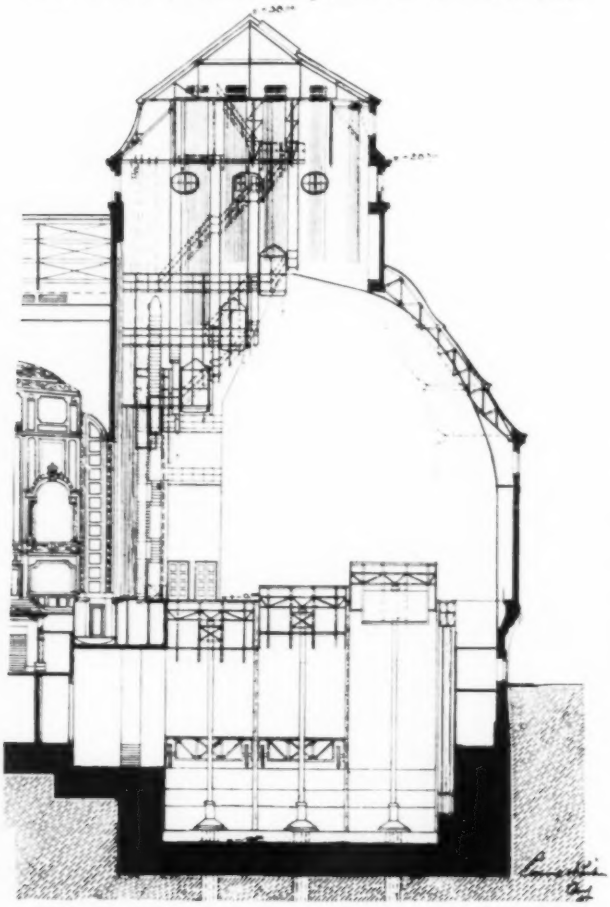
The above is by no means the ideal system of shifting scenery. It is preferable to keep most of the setting intact instead of breaking it into pieces with every shift and to move it by moving the stage itself. This is done in Europe by three systems, all electrically or hydraulically driven.

These are, (1) *a revolving stage* or turntable which comprises most of the stage floor; (2) *sliding stages*, large enough to hold an entire setting, the shifting being done by shunting one set offstage or backstage and sending another on; (3) *elevator stages*, the stage being divided into three platforms usually, running its entire width, so that even the most elaborate settings can be speedily dropped to the cellar and others sent up to replace them.

Unfortunately these labor-saving mechanical aids will probably never be within the reach of the American theatre, for in this field as elsewhere the hope that our machine age can solve any building problem by reducing building costs remains a myth. The initial cost of installing any one of the above systems is prohibitively high. In 1925 when I inquired into the possibility of such a system for the

new Guild Theatre a single section of elevator stage 12 by 40 feet was conservatively estimated at $25,000. To equip the working section of the stage would have involved an expenditure of $75,000. A theatre heavily enough endowed to afford this initial expense will be so rare that we shall probably continue to rely on a manual system of hauling deadweight, slightly aided by counterweights.

Flexibility of the stage floor however must be provided for. The business of a play or the effective design of a set often requires descents to lower levels from terraces, cliffs, or the like. Therefore, the stage floor should be arranged in easily removable sections (traps) on adjustable beams so that any portion of it can be taken out speedily and replaced in the course of a play. Most stages built during the last generation had a single trap downstage center known as the Hamlet trap, which was most often used for the burial of Ophelia by local or visiting stock companies; but a single trap is almost worse than none. The direction of a play or the design of a setting are immensely handicapped unless a stage can be trapped anywhere and to any extent.



DAS NEUE SCHAUSPIELHAUS, DRESDEN, 1913
LOSSOW AND KUEHNE, ARCHITECTS

This theatre has several excellent features: the stage is about 80 feet deep; the stage house is over 100 feet high to the grid; there is a permanent sky-dome; three elevator stages extending from side to side permit rapid and easy shifting of scenery. From the American standpoint, this is a Utopia

THE PROSCENIUM FRAME

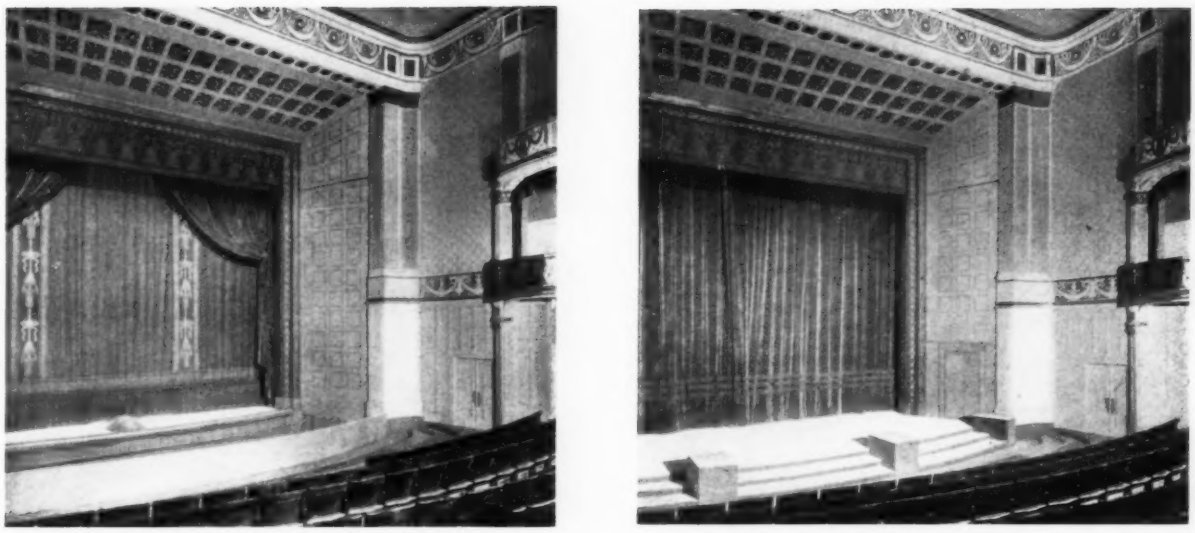
Due to the eclecticism of modern repertory, the revival of classics, Greek or Elizabethan, and the frequent experiments in formal stage, i.e. non-realistic stages in which actors move beyond the proscenium arch or descend to the audience or make entrances from the auditorium, the less the proscenium frame is emphasized by ornament the better. It should be an unemphatic frame, made flexible in size by adjustable draperies or more rigid frames, i.e., inner prosceniums, which should be carefully studied both as part of the auditorium design and in relation to the working of the stage.

A fore-stage is often essential, but it should not be permanent, since it handicaps a more realistic production in which the actors are confined within the limits of a setting behind the proscenium. An elevator platform that can sink to become part of the auditorium floor when not used or below that level to hold an orchestra, is particularly valuable. But with less expense it can be built in removable sections. Portals in a proscenium or in a proscenium frame should be provided and made part of the auditorium design.

THE DEPTH AND WIDTH OF THE STAGE

Though no absolute can be established, I have found in ten years' practice that a thirty to thirty-two foot width is ample for almost every type of production, even the most spectacular, except where chorus girls need to be strung forty feet or more back of the footlights. Moreover fully half the plays given require interior settings. Actors using an imitation of colloquial speech become ineffective when more than fifteen or sixteen feet behind the footlights and a wider opening than thrity-two feet makes for ineffective design because it forces rooms to be more than twice as wide as they are deep. However, the thirty-foot width is best set by an inner proscenium, leaving the permanent opening five to ten feet wider for an occasional pageant or large scale spectacle.

But the width of the stage-house like its height is essential not only for the setting that is in view but for the stacking of settings that are to follow it. Except for low gridiron, insufficient stacking space is the greatest handicap that a production can encounter. The ideal practice is to leave at each side of the proscenium a space of thirty feet to the side walls, a total width exclusive of outside alleys or hallways to dressing-rooms of ninety to one hundred feet of unbroken floor space unencumbered by projections of any kind—except for the two stairways to the cellar, preferably in the up-



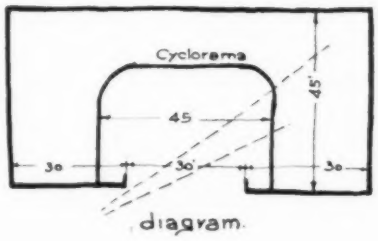
THE VARIABLE PROSCENIUM, DAS GROSSHERZOGLICHE THEATER, WEIMAR, 1908

At the left it is shown with the stage in its usual position; at the right with the stage built forward for a Wortdrama or spoken piece.

stage corners, which are essential for actors to make crossovers during a performance.

The depth of a stage with a thirty foot wide proscenium opening can be safely set at forty feet, though fifty feet is preferable. Of this the rear ten to fifteen feet will be available for stocking space which is particularly valuable when repertory changes from week to week require that several productions be kept available.

Of the forty to fifty feet the playing limits of the stage can be set at a depth of thirty to thirty-five feet, marked by an essential piece of permanent equipment, the cyclorama.



There must be room at the sides. (See text above and below)

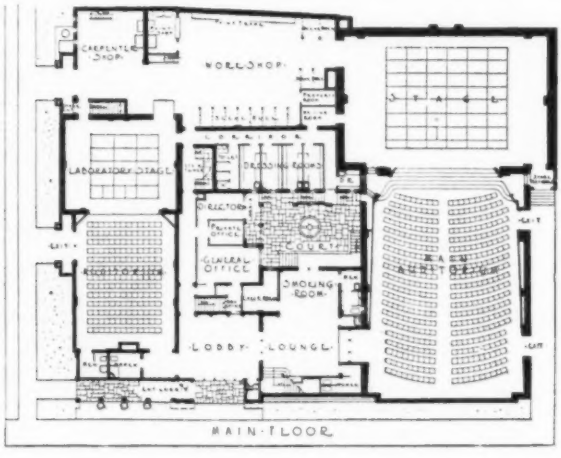
A glance at the sight lines will show that for open-air scenes it is essential to hide side walls and simulate the orb of heaven. This is accomplished by approximating a cylinder of canvas placed forty-five to sixty feet high so that spectators in the front row cannot see over its top, and brought downstage far enough so that those in the side seats cannot look through to the side walls. The canvas cyclorama is the bane of every stage, because none has ever been known to hang flat. The folds destroy every beauty and illusion of atmospheric space which modern lighting can give.

German technicians have perfected cycloramas which are motor-driven on upright rollers, can be spanned in less than a minute, and run in an overhead track, which prevents the huge expanse of canvas from bellying and wrinkling. No one in this country seems capable of reproducing this apparatus. The best substitute available is a cyclorama of canvas mounted on profile (three-ply) board supported by a rigid skeleton frame of wood—a costly and extremely heavy item of equipment because it must be especially counterweighted and electrically hoisted so that settings can be passed under it for scene shifts. (The hoisting of a cyclorama is merely another reason why a high gridiron of eighty to eighty-five feet is always preferable and a low one always causes trouble.) But the added cost of this installation is worth fighting for, since it is only on such a rigid surface that a diffusion of light can be attained, which is so vital an esthetic element in imaginative stage pictures which are part of imaginative stage production.

OTHER STAGE PROBLEMS

In addition to the stage proper, the theatre architect has other problems to solve in his general stage plan, such as the workshop for the stage carpenter, usually in the cellar, where scenery can be repaired or altered; a similar workshop for the

electrician where he can assemble his equipment and store his reserve of lamps, gelatin, cables, and so forth; and another where the property department can make or repair the furniture which the actors handle, and also store between performances properties too valuable to be left on an open stage.



Plan of the Cleveland Play House, showing the extensive off-stage facilities especially necessary to the community theatre that must make most of its own scenes and properties. Philip Lindsley Small and Charles Bacon Rowley, Architects

In a university or community theatre which is too remote from a metropolis to order its scenery from scene contractors and scene painters, and which therefore must plan to build and paint most of its productions with its own staff, these workshops may have to be large enough to become wings to the stage-house proper. They should be considered as an integral part of the theatre plant from the outset. Their efficient layout is as important for a modern theatre as the layout of an operating-room for a hospital, or kitchen and pantries for a hotel.

Storage space, where frequent changes of bills are part of the theatre's program and settings for three or more plays have to be kept available, may involve another addition to the stage-house. This storage space should be made directly accessible to the stage, with a fireproof door large enough so that settings do not have to be dismantled during the few days they may not be in use. A scenic storehouse can be made an integral and valuable element in design, as witness the twin theatres in Dresden where the storehouse forms a connecting link between the large and small theatres and ties them into one architectural unit.

PROVISIONS FOR THE ACTOR

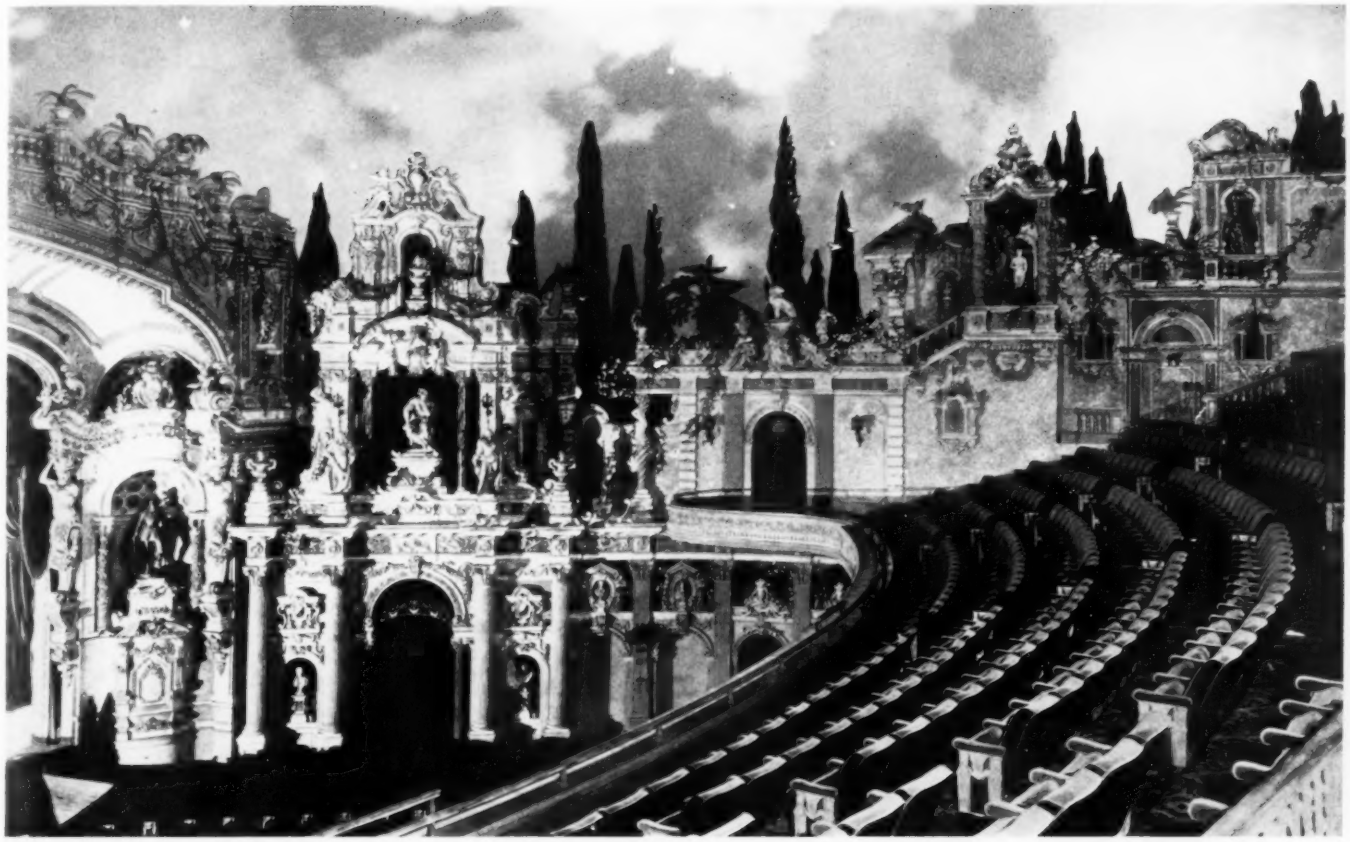
As the casts of many plays run to fifteen and twenty speaking parts, and often more, dressing-room space must be adequate, for no plan of producing only plays with small casts can ever be adhered to. Tradition in the theatre gives the leading players star dressing rooms, limited to one actor apiece. Two of these rooms are usually sufficient. The less important actors can be grouped two, three, and four, in a room. The arrangements for lighting these rooms in order to assist the process of "making up," for providing dressing tables, hanging space for changes or wardrobe, etc., have also been standardized and can be procured as readily as the better makes of plumbing. However, in providing dressing room space several needs are usually overlooked.

1. Two very large rooms where mobs or "extras" often counting up to fifteen or twenty can dress. Failure to provide these means that they have to "make up" underneath the stage, a thoroughly unsatisfactory practice and one forbidden by the fire laws in most communities. 2. Showerbaths should be provided on every dressing room floor as an actor, in "Caesar and Cleopatra" for example, may often have to make up not only his face but his entire body.

The placing of the block of dressing rooms is usually solved by cutting off fifteen or twenty feet of the total width of the lot—which should be kept free for the stage proper. Considerable thought should therefore be given in any theatre plan to providing adequate dressing rooms without cutting down the maximum stage width and at the same time without running the dressing room block up so many stories that quick changes of costume which often have to take place during the course of an act, are not handicapped.

SPACE FOR THE MANAGEMENT

The old-time management usually consisted of the theatre manager himself, a treasurer, and a press agent, who might if necessary be huddled into a single office. But the newer managements undertaking a year-round production plan invariably require larger permanent staffs. Planning for them will require particular study, varying with the organization of any particular group, but providing adequate space for the business or subscription department, press agents, play readers, drafting rooms for the technical staff, and, in connection with university theatres, studios, classrooms, and workshops for instruction in theatrical design. In any organization a rehearsal room should be placed somewhere in the building because two productions may often be in rehearsal at the same time. Particular care should be given to the acoustics of this room. The stage space should correspond to the working area of the main stage: roughly thirty by twenty feet. It is advisable but not necessary for it to be raised above the level of the floor.



AUDITORIUM OF LOEW'S PARADISE THEATRE, NEW YORK CITY

JOHN EBERSON, ARCHITECT

It is the large moving picture and vaudeville house that now draws the speculative profits; being built for the crowds, it must be sumptuous. The drama meanwhile is going into the hands of steady and moderate year-round producers of a new type

THE AUDITORIUM

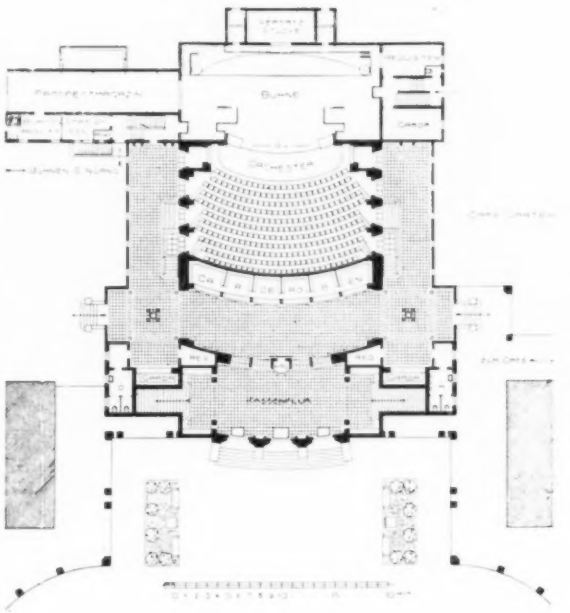
In designing the auditorium the chief benefit to be derived from having as a client the newer types of theatrical organization is the fact that they will have no money to waste on over-elaborate decoration or gilded gingerbread, and no desire to impress their audiences by such means. As they are interested in running the theatre upon a sound production basis, the maximum instead of the minimum of their available capital will go into the items of stage equipment, usually ignored by the speculative theatre builder. For that reason auditoriums will be far simpler in design and materials, and all the better for it.

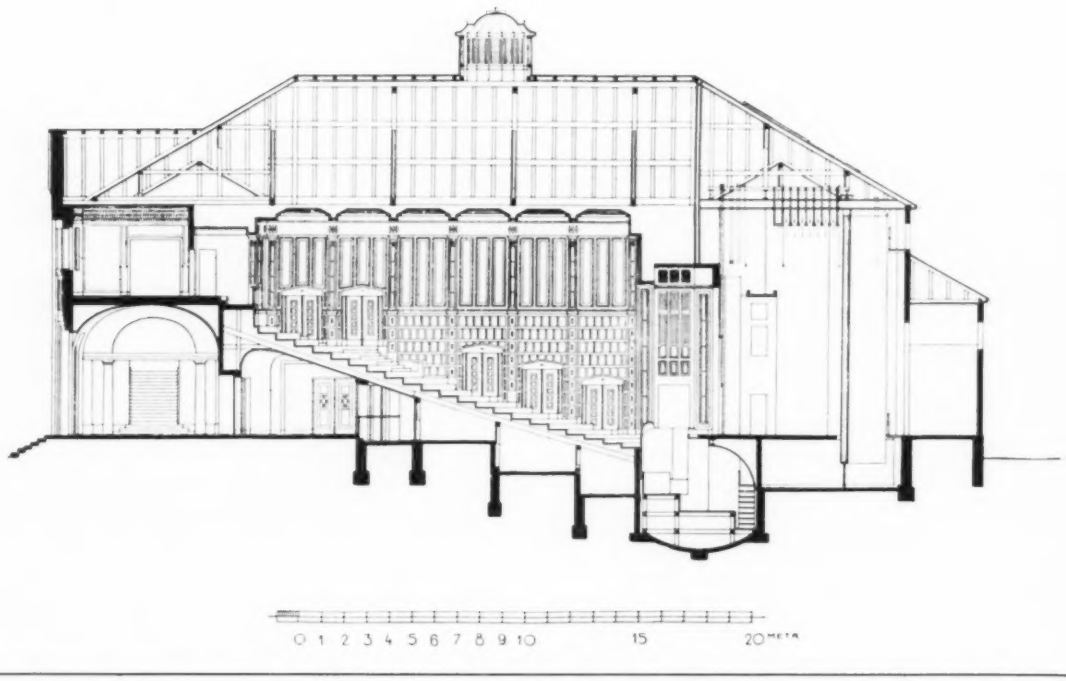
The possibilities here are too many to be discussed within the limits of this article. Nevertheless, one essential feature of planning the auditorium should be reconsidered, namely, that the American system of narrow rows and two or three aisles is neither comfortable nor efficient. A balcony cuts down some of the sight lines of the rear rows of the auditorium underneath it and the rear seats of the balcony almost invariably give an unsatisfactory view of the stage.

The German system, used in many theatres, of building the entire auditorium on an amphitheatre plan, is in every way preferable, particularly where the demand for the number of seats to be sold is not so great as to make it unpractical. In this plan even the rear seats have an excellent view of the stage. Every spectator sees well over every other spectator's head. Every row is an aisle, with two exit doors immediately to right and left for every 2 or 3 rows of seats. The arrangement not only makes for comfort and better sight lines during the performance but in the emergency of a fire will empty the theatre in far less time than our present arrangement.

All current seating methods also tend to get the required number of seats into an auditorium by spreading them out in too wide a fan shape, thus

giving nearly one-third of the house extremely bad sight lines to the stage. The ideal solution is that at the Munich Künstler and Prinzregenten theatres where the seats extend a very few feet beyond the limit of the stage opening. The further advantage of the amphitheatre plan is that it lifts the rear of the auditorium high enough so that the space beneath the rear portion can be effectively used for promenades, smoking-rooms, and so forth. (See cross-section of the Künstler Theatre).





PLAN AND SECTION OF THE KÜNSTLERTHEATER, MUNICH, GERMANY, 1908

MAX LITTMANN, ARCHITECT

The plan shows not only the space set aside for storage, rehearsals, and management, but also the excellent aisle-less auditorium seating plan with exits for every three rows. Distance between rows is sufficient for late-comers to pass without discommoding those already seated. Note the easy sight-lines in both planes. The slope of the floor shown in the section was adapted by the Theatre Guild to American conditions, the space beneath being used for lounges. The Künstlertheater has a very low stage house, built in accordance with special theories of the producer

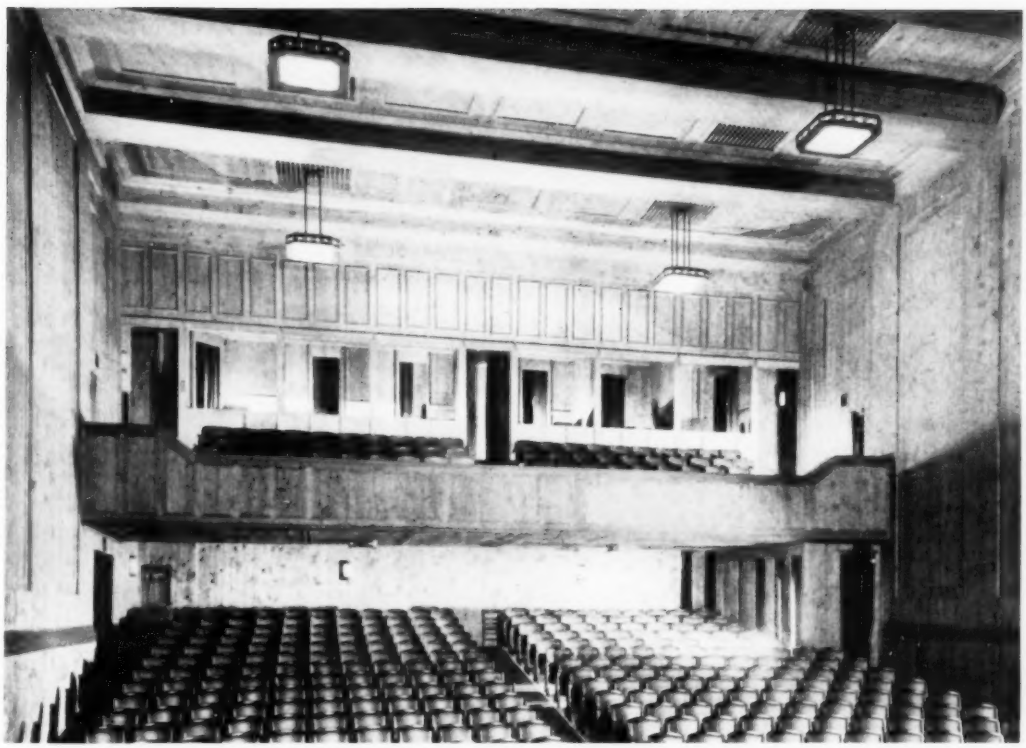


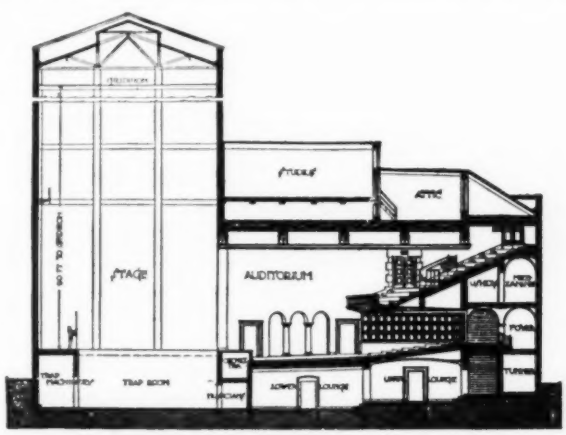
Photo Fischer

AUDITORIUM OF THE CLEVELAND PLAY HOUSE, CLEVELAND

PHILIP LINDSLEY SMALL AND CHARLES BACON ROWLEY, ARCHITECTS

LIGHTING EQUIPMENT

I have left to the last an item of stage equipment so imperative to the proper functioning of a modern theatre that it should, if possible, have been placed at the beginning. No modern production whether realistic or formal can be made effective without the greatest detail and elaboration in lighting. The mood of almost any modern production depends upon the subtle manipulation of the light.



SECTION THROUGH THE GUILD THEATRE, NEW YORK CITY

C. HOWARD CRANE AND KENNETH FRANZHEIM, ARCHITECTS

An adaptation of the section shown on the opposite page

The practice before theatrical production became a modern art was to string a certain number of lights in metal troughs across the stage, flood the stage and the actors uniformly with even radiance which could be switched into two or three colors. This was known as floodlighting, and was thoroughly undramatic in its effect. Its place has been taken by spot-lighting, that is, a large number of electric lamps of from 500- to 1500-watt capacity which can be focused independently over the stage area and lighted in turn in order to cover dramatic fluctuations of the play. These lamps will often run from fifty to one hundred for a single production used in constantly changing permutations and combinations.

In modern producing every lamp occupies the place of an instrument in a symphony orchestra. Each must be individually controlled; that is, taken up or down to any point of intensity, independent of any other. This involves a separate switch for every lamp used, a separate resistance coil or dimmer coil, and a switchboard adequate to handling a hundred lamps when necessary in innumerable shifting combinations.

The nerve center of a modern stage is therefore

the switchboard and its design is of paramount importance. However, it can be planned only in conjunction with a definite lighting system. One of the first steps that an architect must take in planning a stage is to find out how the particular organization for which he is designing plans to light its stage, and then plot the electrical equipment needed. The dimensions of a board, the place it occupies on the stage, and its relation to the lighting equipment, should be finally settled before the stage-house is built as part of the architect's original plan, and not, as is so often the case, be squeezed in after the stage-house is already in construction or cut down because space for the board required has not been forseeen and provided for. A lighting engineer should be called into conference *before*, not after, the first blueprints are made.

The technical requirements of a switchboard are too many to be detailed here. The main object to be kept in view is the compactness of the board itself so that a single electrician can control the manipulation of lights through the play which may often run to a hundred or more light changes or light cues in a single evening.

The difficulty with most standard switchboards is that the handles controlling the switches are interlocked as a separate unit from those controlling the dimmers, so that a light has to be turned on in one section of the board and controlled in another, producing great inefficiency and inflexibility in handling the lights when it does not demand a human being with four to six arms. The dimmer boards on which the switches are mounted integrally with the dimmer handles, particularly those with magnetic or remote switch controls with which many changes of lights can be pre-set—therefore making the design of the board far more compact, easily read, and easily controlled—are in every way preferable.

At the moment further progress is imminent. A system of electrical control seems on the point of being perfected such that the actual controlling mechanism on the stage will be tremendously reduced in size and controlled by handles no larger than those of radio dials, capable of pre-setting two and three light changes and controlling as well the speed of these changes from fifteen minutes to one second, with the bulky part of the equipment, the dimmers themselves and the switch contactors stored underneath the stage in the cellar.

The lighting of the stage that I have found most effective consists of lighting from both sides and overhead, the side lighting being done behind the inner proscenium by spotlights clamped to an upright metal pipe and running from twenty to twenty-four feet. Fifteen photolights can be placed on each side, angled over the playing area, reangled, and their colors changed if need be between the acts. From the bridge overhead twenty or more spotlights can be hung and similarly used.

The lighting of the sky involves a separate set of lights, worked on a three-color system in which red, blue, and green lights are mixed in order to give the range of the spectrum. The spacing and hanging of these must be considered in laying out the gridiron plan and providing special counterweights when the installation is large enough to require them. Footlights can never be relied upon to offset the occasional facial shadows cast by overhead lighting without destroying the balance of all other light on the stage when used to their full capacity. They must be supplemented and can often be replaced by spotlights thrown down on the fore-part of the stage from in front of the proscenium. The ceiling of the auditorium must be designed to conceal them.

In addition every stage needs base receptacles known as "stage pockets," which will hold a minimum of six stand lamps to throw through entrances, windows, etc. and for which the wiring conduits must be provided in planning the stage floor.

V.

This outline is no more than a bare skeleton of the theatre's requirements and necessarily ignores any number of special problems which arise in the construction of any playhouse. Our newer theatres will probably involve more than an auditorium and stage proper because they tend to be centers of university or community life. The foyers will be far more important than they are in the Broadway theatres of today where they serve simply as a space to wait for a taxicab. They will be planned on a far more ample scale as a center where permanent theatregoers can meet not only during intermissions but at lectures, and exhibitions, when performances are not being given. The theatre building will be planned not only for the stage but for its relation to the group activities of a community or university. The theatre architect will therefore have the additional incentive of meeting in his plan not the commercial greed of a real estate speculator but the keenest esthetic interests of which American communities are capable. For that reason theatre planning in America within the next decade may become not only sounder in its technical basis but more significant in architectural design as well.

PROCEDURE IN DESIGNING A THEATRE

BY ROBERT L. DAVISON

We express appreciation for the cooperation of the following:

A. D. Hill, of Hodgens and Hill, Theatre Architects, for practical suggestions on procedure in theatre planning.

S. R. McCandless, Professor of Lighting, the Department of Drama, Yale University, for valuable information on lighting and mechanical equipment.

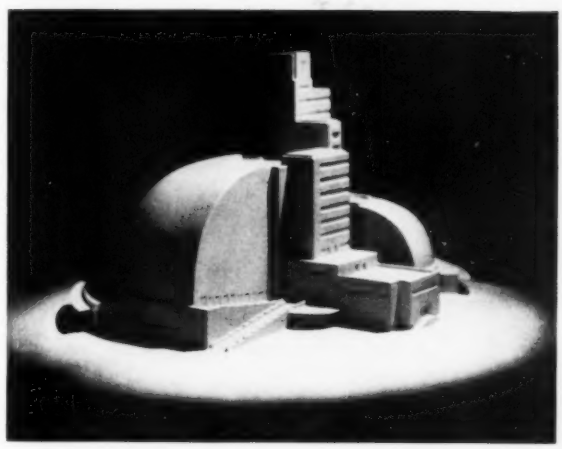
Munroe R. Pevear, of Boston, Illuminating Engineer and designer of stage lighting equipment, for advice on problems of theatre lighting.

Peter Clark, designer and manufacturer of stage rigging, for details of stage rigging and for criticism of this article from the standpoint of current commercial practice.

A. B. Randall, for the formula to determine sight lines in a theatre.

Wm. F. Wilmurt, Milton Lowenthal, and Emilio Di Rienzo, School of Architecture, Columbia University, for valuable assistance in collecting data for this article.

We also acknowledge valuable assistance from Lee Simonson on stage design, and from Kenneth Macgowan, who supplied data on the Community Theatre. There were also a number of architects who graciously lent assistance and supplied plans and photographs without which the article would have been impossible.



Above: Model by Norman Bel Geddes of a self-contained group of theatres proposed for the Chicago World's Fair of 1932

SPECIAL NOTE: The problems of acoustics and lighting in theatre auditoriums will be separately treated in another number of the ARCHITECTURAL RECORD soon.

NEXT MONTH: GASOLINE FILLING AND SERVICE STATIONS

Sketch of a proposed METROPOLITAN OPERA HOUSE for New York; JOSEPH URBAN, Architect

PROCEDURE IN DESIGNING A THEATRE

BY ROBERT L. DAVISON

I. GENERAL LAYOUT OF BUILDING

In order to illustrate a method of procedure in the preparation of plans for a more or less *standard, medium-sized, average theatre*, we will assume a plot of ground 110 feet wide and 180 feet deep. The theatre should be designed for use either as a legitimate theatre or for movies, as conditions may warrant a change from one type of production to another, but even if it were used exclusively for movies, there would still be the advisability of stage room for prologues or vaudeville acts.

Because of wide variations in local requirements no attempt has been made in this study to differentiate between motion picture houses, presentation houses, hired legitimate theatres, and what might be called the community or experimental theatres.

A. PREPARATION OF PLAN

All plan dimensions forward or backward from the stage are given in relation to the "curtain line." Dimensions to the right and left are taken from the center

line of the proscenium arch, drawn at right angles to the curtain line. Vertical dimensions are figured in their relation to the elevation of the stage floor, which is taken as zero. The plan is developed only after these three lines have been located.

1. CENTERLINE. On the ground plan draw the central line for the long axis and mark off, from the rear lot line of this axis, the following points: (asbestos) curtain line 30 feet; add 2 feet for proscenium arch and 2 feet to the edge of the apron; add 13 feet to rail dividing pit from auditorium; add 5 feet 6 inches to the back of first row of seats, and then lay off rows of seats 32 inches on center.

Allow a 10-foot court on each side of the auditorium extending from the stage to the street (the width of courts varies, from five feet upward, according to the local or State laws. The building code recommended by the National Board of Fire Underwriters specifies 10 feet for theatre with audience of 1,000 and one foot additional for each additional 500 or fraction thereof). Draw lines parallel with this court line 2 feet inside to indicate line of inner wall and columns. Take a point on the axis 20 feet in rear of the rear lot line as the center point for radius for establishing curve for seats. Using this point, draw an arc through the point established on the axis for the back of the first row of seats.

2. LOCATION OF SCREEN AND PROSCENIUM ARCH. Indicate a 42 foot wide screen, 8 feet back stage from the curtain line. Establish two points on the inside wall 50 feet in front of the curtain line. Draw lines from the end of the screen to this point. These are lateral sight lines. The proscenium opening should clear these lines. Establish the stage wall on each side of proscenium arch 6 feet forward from the curtain line. Draw in the side wall lines from the 50 foot point to the stage wall, allowing a 3-foot distance from the sight line to the point where it intersects the first row of seats. The front wall of the stage from this point will drop back to the front edge of the proscenium arch. Allow four feet from the sides of the proscenium to the sides of the orchestra pit. Draw in the orchestra pit, using radius point previously established.

3. LAYOUT OF SEATS. A bank of 13 seats, which is the number usually permitted under building codes, occupies 22 feet. (If 22″ per seat is allowed the section will occupy 23.8′.) Block in this section of seats 11 feet on side of centre axis. On each side of the centre bank at the orchestra pit, indicate a 3-foot wide aisle which shall increase approximately 1½ inches in every 5 feet toward the rear of the theatre, so that, 80 feet from the orchestra pit, the aisle will be 5 feet wide.

Next, draw in the wall aisles allowing 3 feet width at orchestra pit (minimum required by law is usually 2 feet) and 1½ inches additional for each additional 5 feet in length. Wall aisles are sometimes omitted in which case 7 seats may be placed off from the aisle. Before determining the rear standing rail it is now desirable to work from the street side.

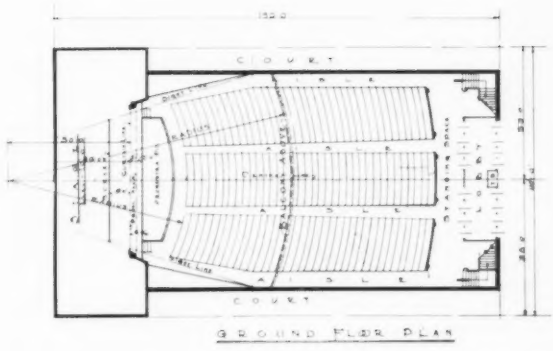
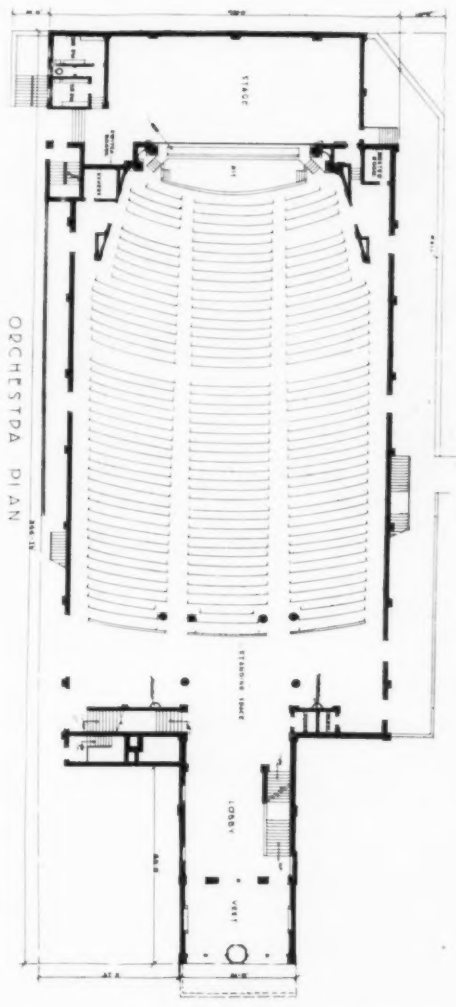
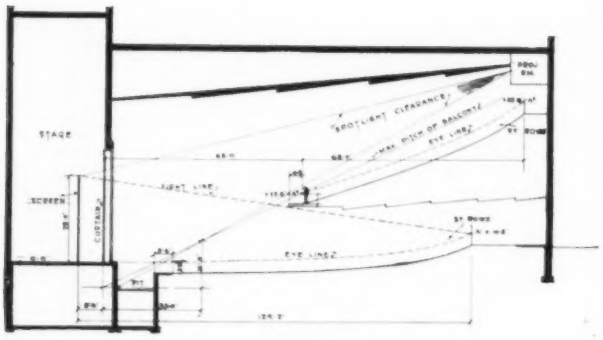


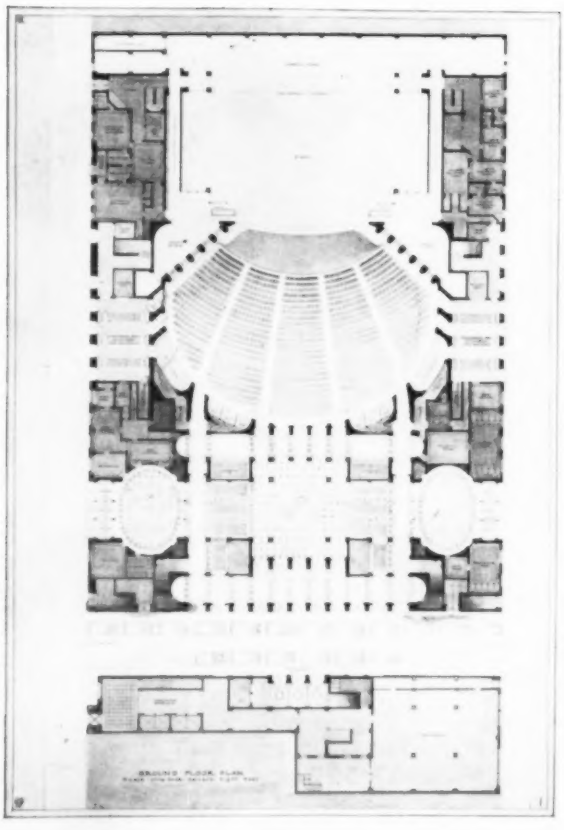
Illustration of procedure in laying out a theatre plan. See text at the left, and section on next page



Plan of a MOVING PICTURE THEATRE in Philadelphia; H. C. Hodgens and A. D. Hill, Architects. Motion picture houses require stage space for occasional presentation plays and for vaudeville acts



Section illustrating procedure in laying out a theatre plan. See text, beginning on previous page



GROUND FLOOR PLAN of a proposed METROPOLITAN OPERA HOUSE for New York City; JOSEPH URBAN, Architect

4. ENTRANCE AND STANDING ROOM REQUIREMENTS. Most building codes require 1½ square feet of entrance and standing room per seat, and many of the large theatres provide considerably more space than this. Assuming the auditorium to have 3 banks of 35 rows with 13 seats in a row, the seating capacity for the first floor will be 1,350. This number of seats multiplied by 1½ square feet = 2,025 square feet of standing room required which, divided by the width of the building (110–10–10 = 90) gives 22½ feet from street to standing rail back of last row of seats. As a certain amount of room will be occupied by ticket booth and walls, it will probably be desirable in preliminary sketch plan to allow at least 24 feet from street to last row of seats.

Locate the ticket booth (at least 4 feet x 5 feet in area) in center of entrance lobby and estimate the door space required on each side of the ticket booth. Building codes vary, but for the purpose of illustration assume that a minimum of three 5-foot doors are required for the first 500 seats and that each additional 100 seats require 20 inches more door space. Assuming that the theatre may seat two thousand people, including the balcony, the required door width would be (2000-500) $\times \frac{20''}{12''}$ = 25 feet. Three 5-foot doors + 25 feet additional = 40 feet of doors to be provided. This will establish the width of lobby over the width of ticket booth. For the average theatre of this size allow a 12-foot to 16-foot deep lobby (unless it is to have stores), a second tier of doors and 12 feet standing space between inner lobby doors and standing rail in rear of last row of seats. Place any columns needed on line of standing rail.

5. LOCATION OF TOILET ROOMS. If the theatre is not to have a balcony, the ladies' and men's rooms may be located either above the entrance lobby on either side of the projection booth or in the basement.

6. BALCONY. If the theatre is to have a balcony, assume a point approximately 65 feet back from the curtain. Use the radius point previously established and rough in the seat plan of the balcony. From the front of balcony to the back of the first row of seats there should be a distance of 4 feet. In the balcony, because of the effect of the rise on leg room, the distance from row to row should be not less than 33 inches, this distance depending largely on the slope of the floor.

7. STAIRCASES AND VOMITORIES. For a building of this size, it is probably desirable to provide a 5-foot wide cross-over aisle about 10 rows back from the front which will connect with the vomitories which should come in on the wall sides so that the crowds will not stand in front of people who are seated. Vomitories should never be less than 8 feet in width.

Width of stairs from mezzanine or balcony to main floor are generally covered by local building or fire codes but generally a 4-foot wide stair is required for the first 50 seats and 6 inches more width for each additional 50 seats. Hand rails should be provided on both sides and

when the width exceeds 7 feet, there should be a hand rail in the center.

B. Longitudinal Sections Through Theatre.

a. Vision Lines. In designing a theatre it is of utmost importance to provide for good vision from every seat in the house. Most methods in use today in offices are largely a matter of experience rather than a scientific method for providing ideal sight lines. For the rule-of-thumb method see marginal note.

Using the mathematical method which follows, the architect may determine ideal sight lines and then make such sacrifices as are necessary to keep down the cost of stepping the auditorium floor.

In the following example we have compromised to the extent of providing sight clearance over heads of those in third rather than second row ahead of the eye level of row being figured.

Procedure.

To find the *level of the eye* above the stage in any given row, the following procedure* should be used:

1. Select a focal point to be seen by all spectators. (In this case the intersection of the stage and the curtain line.)

2. Determine the distance from the focal point, of the eye of a person in the first row of seats, and its height above this point. See table on page 466.

(When the distance does not conform to one shown in the table, use next spanning interval below same, i. e., closer to the stage. Thus, if the eye at the first row be 22′0″ from the point selected, with 32-inch seat spacing, use 21.33′, the next lower spacing.) The height of the eye above the stage in the first row should be 4″.

3. Determine the distance (by referring to table) of the row in question from the focal point.

4. Decide on a desirable clearance from row to row.

In the accompanying example we will use a 1.33″ rise per row, i.e., the line of sight of a spectator in any row will be 1.33″ above that of the person ahead at that point. This provides for a sight line clearance of the heads of persons in the third row ahead of the spectator. This condition should be fairly satisfactory for comfortable vision in a theatre. (Two inches per row are preferable.) In stadiums where spectators wear hats, as much as 4-inch clearance per row is often desirable.

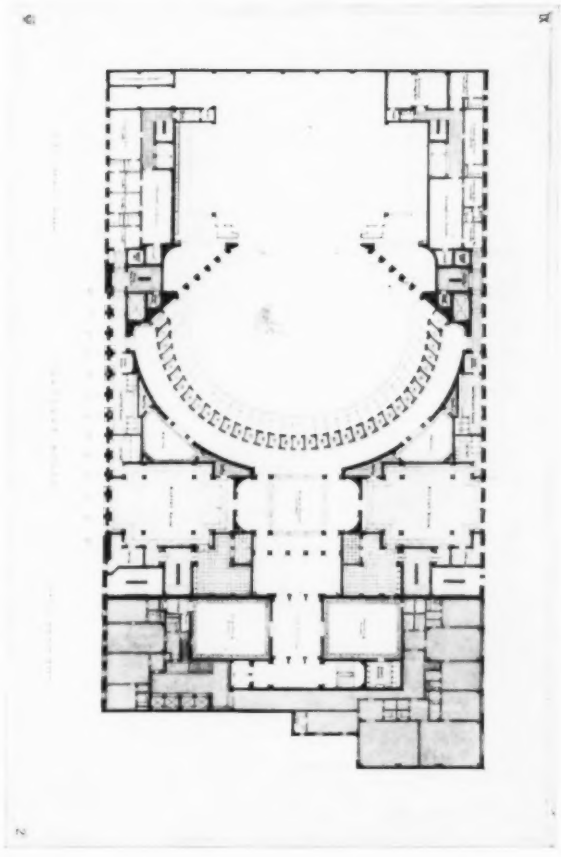
Formula. The formula for finding the eye level follows:

$$e_n = \left[\frac{e_1}{d_1} + c \left(\frac{1}{d_1} + \frac{1}{d_2} + \cdots \frac{1}{d_{(n-1)}} \right) \right] d_n$$

In which e_1 = eye height of 1st row spectators.
e_n = eye height of nth row spectator.
d_1 = distance from focal point to 1st spectator.
d_n = distance from focal point to nth row spectator.
c = rise per row (1.33″ or $^1/_9$′ in our case).

Application: Using the condition in the type of theatre

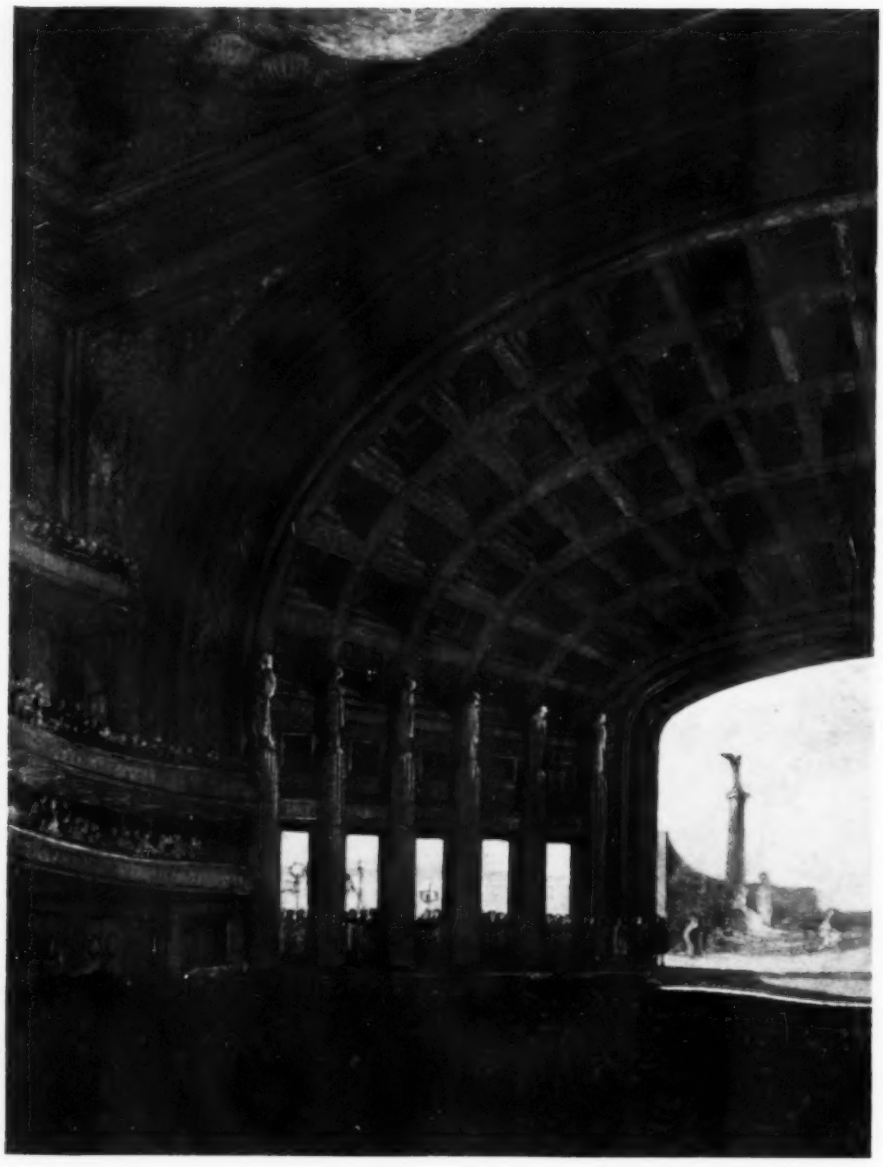
*This method of determining theatre sight lines was prepared for us by Mr. A. B. Randall. For complete discussion of mathematics and theory involved and for application to stadiums see The American Architect and Architectural Review—May 21, 1924.



Parterre boxes in a proposed metropolitan opera house for New York City; joseph urban, Architect

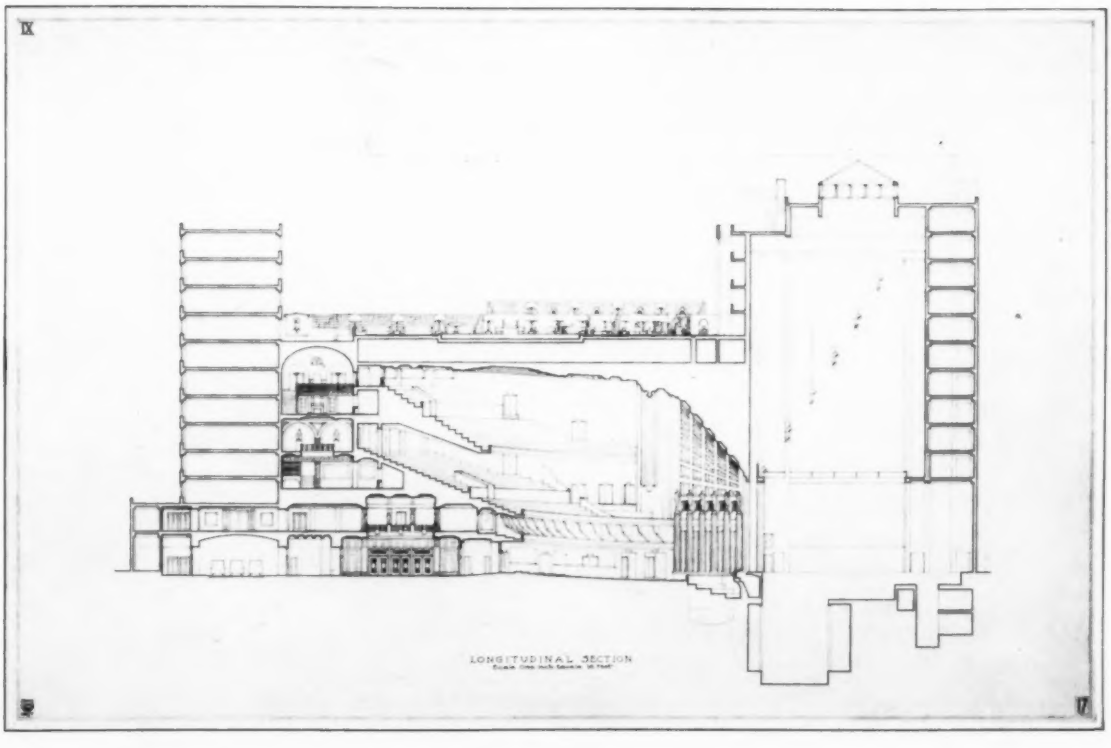
SIGHT LINES BY SHORT METHOD

The rule of thumb method for determining sight lines, not entirely accurate but which is frequently used, is as follows: the floor grade is established at approximately—3′4″. The architect lays off the floor grade using ¼″ rise per foot run for first 16 feet, then ½″ per foot rise for the next 16 feet, 1″ per foot for next 16 feet and so on doubling the rise every 16 feet. If this gives too much pitch or results in too high a grade for the rear row of seats the original rise is reduced and the processes repeated till the desired results in pitch and grade (not sight lines) are obtained



Proposed Scheme for METROPOLITAN OPERA HOUSE, New York City; JOSEPH URBAN, Architect.

Proscenium shaped like human mouth for acoustical reasons.

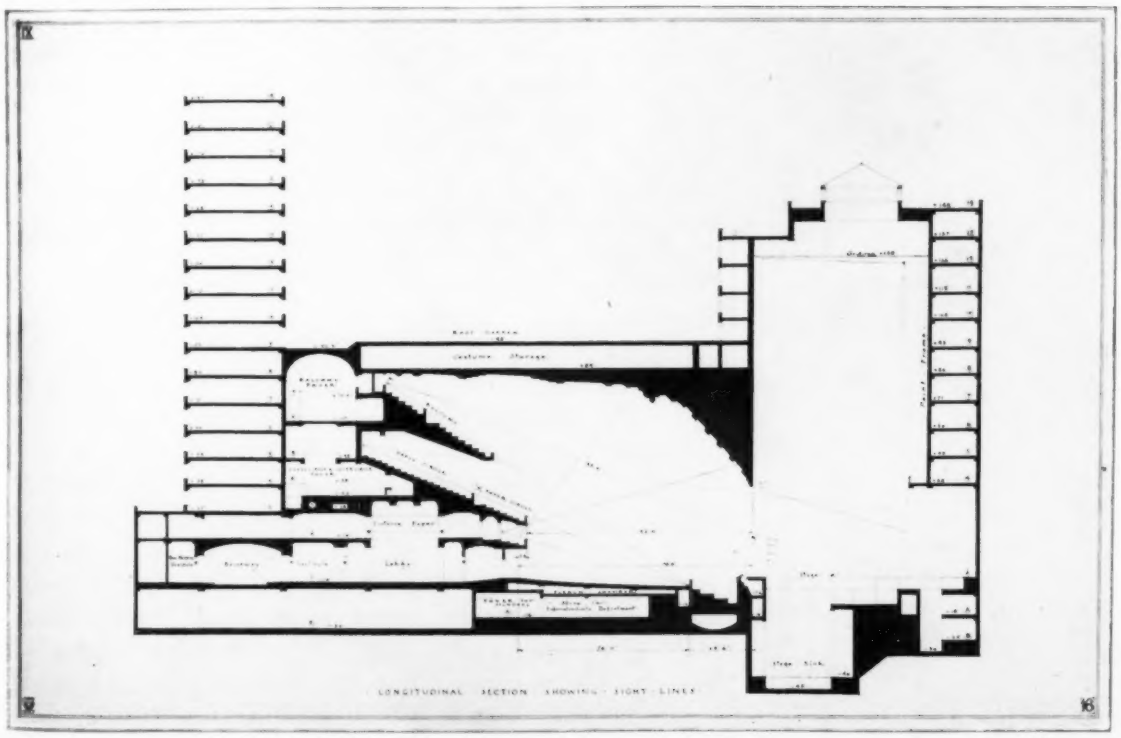


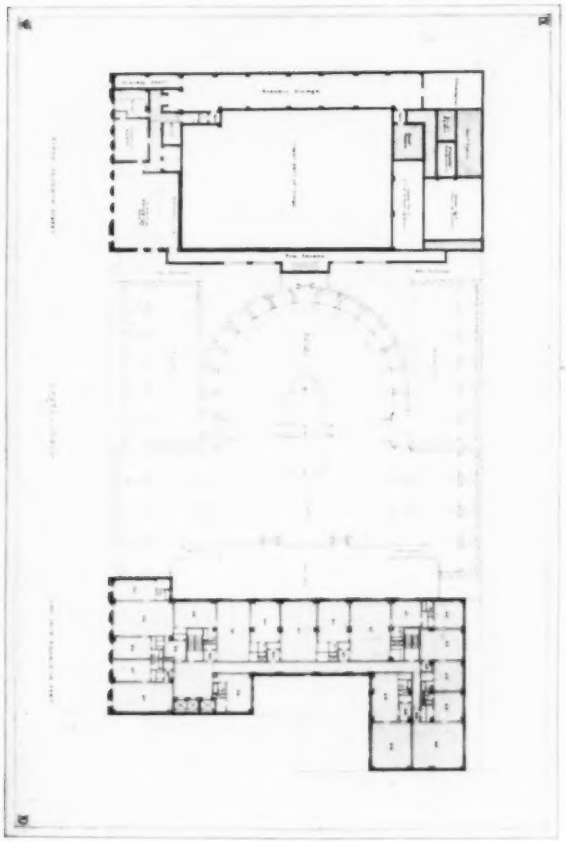
Proposed Scheme for METROPOLITAN OPERA HOUSE, New York City; JOSEPH URBAN, Architect.

In addition to the opera house proper, provision was made for studio apartments for opera stars, playgrounds for children and gardens on the roof.

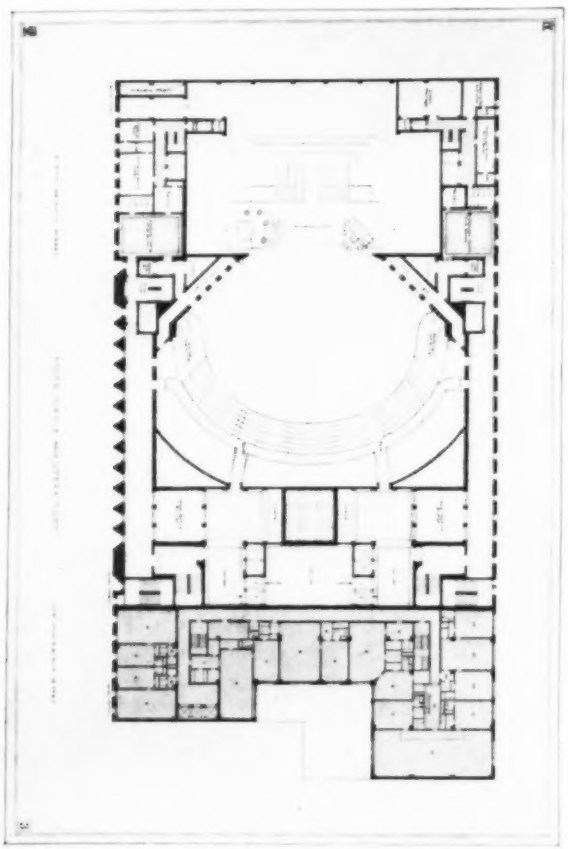
The entire scheme was worked out to meet the very exact requirements of opera production.

Box holders have a private automobile entrance that passes through the building. The separate entrance for impressarios is by an underground passage.





Above, ROOF PLAN; below, FOYER CIRCLE AND OPERA CLUBS, of a proposed METROPOLITAN OPERA HOUSE for New York City; JOSEPH URBAN, Architect



illustrated, (page 460) as an example, we will find the height of the eye in the last row of the auditorium.

e_1 (8 spans, @ 32″, from focal point)=0.33′.
(i.e., eye level in first row is 4″ above focal point.)

d_1=21.33 (table) (actually 22′6″ but by using 21.33 any discrepancy is in favor of better conditions).

e_{37}=unknown to be found.

d_{37}=120 ft. (see table.)
[1st row is 8 spans from focus, 37 additional rows is then 45 spans from focal point, or 120′.]

Setting up the formula with values substituted we have

$$e_{37}=\left[\frac{.33}{21.33}+1/9\left(\frac{1}{21.33}+\frac{1}{24.00}+\ldots\frac{1}{117.33}\right)\right]120.00$$

The parenthesis is the sum of the reciprocals of the distances of the first row to one less than the row in question. These reciprocals are given conveniently for a 32-inch seat spacing in the table, if a simple subtraction is made.

For example: The value of the sum of reciprocals between 16′ (where table begins) and 117.33′ (which is one space less than 120′) is seen from the table to equal .783513 (which is read opposite 120′ in the table). The value of the sum of the reciprocals between 16′ and 18.67′ (one space less than 21.33) is .116062 (opposite 21.33). The value of the sum of reciprocals between 21.33′ and 117.33′ is therefore equal to the difference between .783518 and .116062 or .667451.

Thus the formula becomes:

$$e_{37}=\left[0.155+\frac{.667451}{9}\right]120$$

e_{37}=10.76′ (Level of eye in 37th row)

Other levels may be found at any row and the curves for auditorium and balcony so determined.

Having found the eye height in the last row of the auditorium, the next step is to locate the level of the eye in the first row of the balcony. The balcony must be above the vision line determined by the eye level in the last row of the auditorium and the top of the screen. Also, the balcony should not be nearer the stage than the intersection of the above mentioned line of vision and a line with a rise of 16 to a run of 33, starting at a point 8 feet below the focal point. Having found this point, we can easily pick a row (from the table) a little further from the stage than this point.

With this lower edge of the balcony established on the vision line, set slightly behind the intersection mentioned, the eye height can be determined by adding 1′2″ for construction of balcony and 3′8″ for height of eye from floor. The distance of the eye from the front of the balcony must also be considered (4′).

With this distance and height it is a simple matter to find the height of the eye in the last row of the balcony. Other points may be found in the same manner.

It will be seen that the height of the theatre is determined by the conditions of good vision, inasmuch as the height of the eye in the last row balcony less 3′8″ gives the floor height. The necessary 9 feet headroom determines the underside of the projection booth. The

Above, SKETCH OF FOYER; below, PLAN AT 82-FOOT LEVEL, of a proposed METROPOLITAN OPERA HOUSE for New York Ctiy; JOSEPH URBAN, Architect

main steps of the computations for the typical theatre described in this article are given below in a simplified form.

1. By referring to diagram the steps may be easily followed to determine the height of the eye in the *last row of the auditorium.*

e_n = ? (to be calculated when n = 37th row)
e = 4″ or .33′
d = 21.33 (first row auditorium) 8 spans @ 32″ from focus
c = $^1/_9$
d_n = (for 37th row or 45th span, at 32″ spacing from focus)

$$e_{37} = \left[\frac{.33}{21.33} + \frac{1}{9}\left(\frac{1}{21.33} + \frac{1}{24} + \ldots \frac{1}{117.33}\right)\right] 120$$

ΣR 120 = .783513
(Sum of Reciprocals)

$$\Sigma R \quad 21.33 = \begin{array}{r} .116062 \\ 9\overline{)\,.667451} \\ .074161 \end{array}$$

e_{37} = (.0155 + .074161) 120
e_{37} = 10.76′ eye level in last row of auditorium

2. To determine height of eye in *first row balcony.*

By solving similar triangles (the distance of last row from the screen and the height of the screen being known) the vertical from the underside of the balcony to the horizontal through the eye of the last row spectator is found to be 8.18′. The height of the eye in the first row balcony is the height of eye in the last row of auditorium (10.76′) + the vertical (8.18′) + construction (1.33′) + height of eye of seated person (3.67′).
This gives 23.94′ for eye height from stage floor (datum level of focal point).

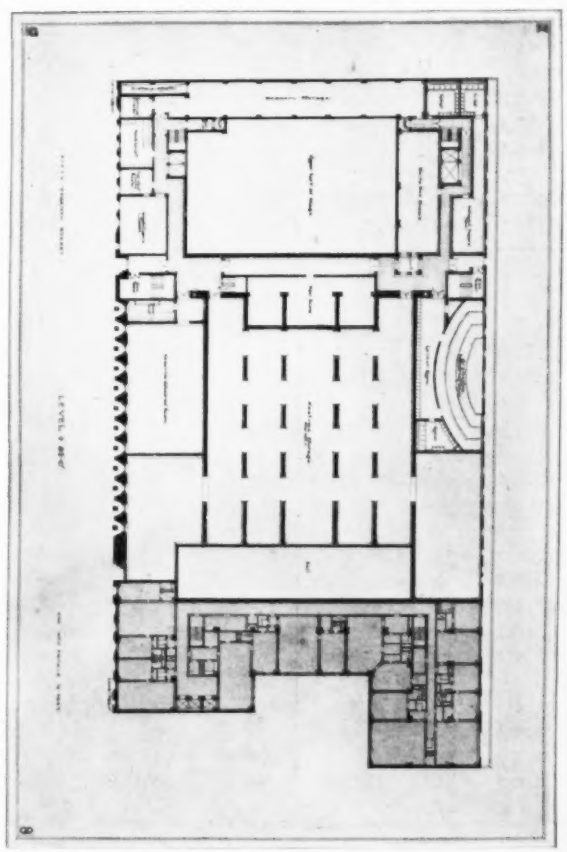


TABLE OF RECIPROCALS for Determining Eye Height (See text beginning on page 461).

TABLE FOR 32″ ROW SPACING Spacing = 32″ = 2.67′			TABLE FOR 36″ ROW SPACING Spacing = 36″ = 3′		
distance in feet	K (No. of Row) d–s	Reciprocal	distance in feet	K (No. of Row) d–s	Reciprocal
16.00	6	0.000000	15	5	.00000
18.67	7	.062500	18	6	.06665
21.33	8	.116062	21	7	.12221
24.00	9	.162944	24	8	.16982
26.67	10	.204611	27	9	.21148
			30	10	.24852
29.33	11	.242106	33	11	.28185
32.00	12	.276201	36	12	.31215
34.67	13	.307451	39	13	.33992
37.33	14	.336294	42	14	.36556
40.00	15	.363082	45	15	.38937
42.67	16	.388082	48	16	.41159
45.33	17	.411518	51	17	.43242
48.00	18	.433578	54	18	.45203
50.67	19	.454411	57	19	.47055
53.33	20	.474147	60	20	.48809
56.00	21	.492898	63	21	.50475
58.67	22	.510755	66	22	.52062
61.33	23	.527799	69	23	.53577
64.00	24	.544104	72	24	.55026
66.67	25	.559729	75	25	.56414
69.33	26	.574725	78	26	.57747
72.00	27	.589149	81	27	.59029
74.67	28	.603037	84	28	.60264
77.33	29	.616429	87	29	.61454
80.00	30	.629361	90	30	.62603
82.67	31	.641861	93	31	.63714
85.33	32	.653957	96	32	.64789
88.00	33	.665676	99	33	.66830
90.67	34	.677040	102	34	.66840
93.33	35	.688069	105	35	.67820
96.00	36	.698784	108	36	.68773
98.67	37	.709201	111	37	.69699
101.33	38	.719336	114	38	.70600
104.00	39	.729205	117	39	.71477
106.67	40	.738820	120	40	.72332
109.33	41	.748195	123	41	.73165
112.00	42	.757342	126	42	.73978
114.67	43	.766271	129	43	.74771
117.33	44	.774991	132	44	.75546
120.00	45	.783513	135	45	.76304
122.67	46	.791846	138	46	.77045
125.33	47	.799998	141	47	.77770
128.00	48	.807977	144	48	.78479
130.67	49	.815790	147	49	.79173
133.33	50	.823443	150	50	.79856
136.00	51	.830943	153	51	.80523
138.67	52	.838296	156	52	.81177
141.33	53	.845507	159	53	.81818
144.00	54	.852583	162	54	.82447
146.67	55	.859527	165	55	.83064
149.33	56	.866345	168	56	.83670
152.00	57	.873042	171	57	.84265
154.67	58	.879621	174	58	.84850
157.33	59	.886087	177	59	.85425
160.00	60	.892443	180	60	.85990

3. To determine height of eye in *last row of balcony*.

$e_n = e_{27} =$ (27th row of balcony + 24 spans @ 32″ from focus)

$e_1 = 23.94'$

$d_1 = 64.00$ (distance from focal point to eye in first row balcony)

$d_n = d_{51} = 136'$ (distance to eye in 27th row balcony)

$$e_{27} = \left[\frac{23.94}{64.00} + \frac{1}{9}\left(\frac{1}{64.00} + \frac{1}{72} + \cdots \frac{1}{133.33}\right)\right] 136$$

$\Sigma R\ 136 = .830943$

$\Sigma R\ 64.00 = .544104$

$9 \mid .286839$

$.031871$

$e_{27} = (.3738 + .031871)\ 136$

$= 55.18'$ height of eye in last row balcony.

By similar computations, other points in the curve may be determined. The section is always a flat curve at the beginning getting steeper progressively to the rear.

It is advisable to compute the last two rows of the balcony so as to be sure that the rise per row is not greater than that allowed by law (1′9″).

For differently spaced rows other tables are necessary.

The method of making a table, using for example 36″ spacing, follows:

List the distance starting with about 15 feet since no row is likely to be closer to the stage than this, due to the orchestra pit. These distances are shown in the first column.

For convenience, list the number of spans from the focus in the second column.

In the third column set down the reciprocals of the distances in the first column.

Set zero in the fourth column opposite the initial distance of the table (here opposite 15 feet).

Column I Distance In Feet	Column II Space From Focal Point	Column III Reciprocal of distance	Column IV Sum of Reciprocals
15	5	.06666	.00000
18	6	.05555	.06666
21	7	.04761	.12221
24	8	.04166	.16982

The reciprocal of 15 is placed opposite 18 and the sum of these is placed opposite 21. This sum plus the reciprocal of 21 is placed opposite 24.

All items continue, except that the sum of reciprocals is made to include only up to the reciprocal of the next previous distance in order that the table read the sum of reciprocals from the start up to and including the last distance proceeding the one in question.

$$\text{i.e., } \left(\frac{1}{d} + \frac{1}{d_2} + \frac{1}{d_3} \cdots \frac{1}{d_{n-1}}\right)$$

The result is the table which is shown at the left.

II. PRODUCTION REQUIREMENTS

A. Projection Room.

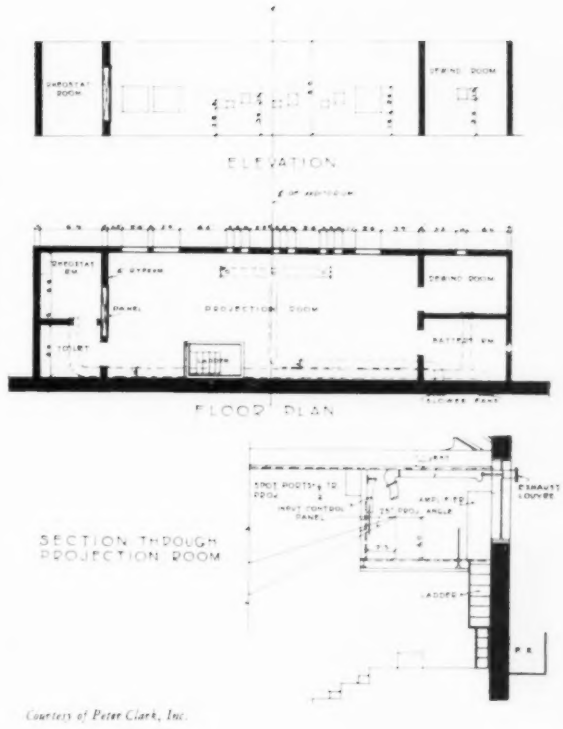
The projection room should be drawn 12 feet out from the rear wall with the under-side of the floor 9 feet above the rear floor of balcony. The line of sight should be established 4 feet above the floor of the booth. The projection angle should not exceed 25°. Lines indicating clearance of spotlight should be drawn from this outlet to the auditorium edge of the orchestra pit and to the under-side of the proscenium arch. A vertical line 6 feet long should be drawn at the forward point in the balcony to indicate that a person standing would not interfere with light from projection booth. This would seem to be a simple precaution but has, at times, been overlooked.

B. Stage.

1. types. The simplest type of stage, which is to be avoided whenever possible, is that with little or no fly space. Such stages are too often installed in schools, hotel ballrooms, and other similar places, and are a great handicap even to amateur productions. If there is absolutely no way to get fly space over the stage, a plaster sky dome may be constructed, few hanging pieces being necessary with this type of stage. Great care must be taken in the design and finishing of such a dome because the slightest variation in the flow of the curves will distort the lighting. A light trench 4 feet wide should be built in the floor in front of the dome. Sometimes a hung grid is used, with a saving of the space above it; but hung grids are not really satisfactory. On stages used primarily for purposes other than dramatic production a portable grid can be used.

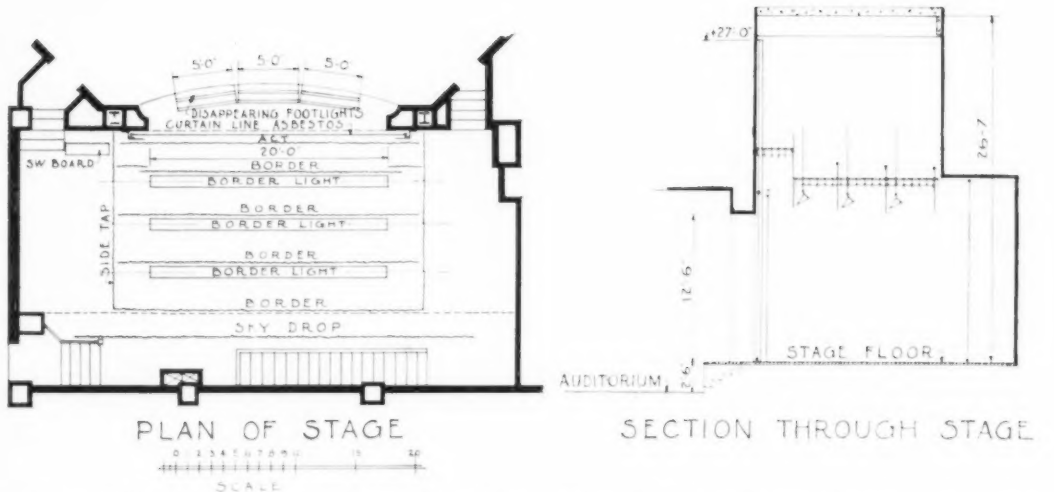
The usual type of theatre used for legitimate production is that with very generous loft space and is discussed in detail below. Sometimes, especially in Europe where the stage is very deep, permitting scenery in front of dome, a sky dome is constructed. The Dresden Court Theatre has one that is hinged so that the dome part may be swung back out of the way for hung scenery.

Then comes the more elaborate type with two or more stages mechanically operated so that while one set is being used the next can be set up, making a very quick change of scenery even with elaborate sets. These stages are devised in various ways. First there is the revolving stage which is more often used than the others because it takes up less room; next there is the wagon stage. This type is constructed so that there are two stages running on one set of rails, one being before the proscenium opening while the other is off to one side out of vision. This necessitates a total stage width of a little more than three times the proscenium opening. Sometimes a third stage is built so that it will roll to the rear of the playing area. Another, and probably the most complicated, system is that which has a set of stages and tracks as described above, but located in the cellar. In this case the set to be used is rolled into position below the stage and then raised to stage level by an elevator. When the act is finished the set is lowered, moved off the elevator, the next is slid on and in turn raised up.

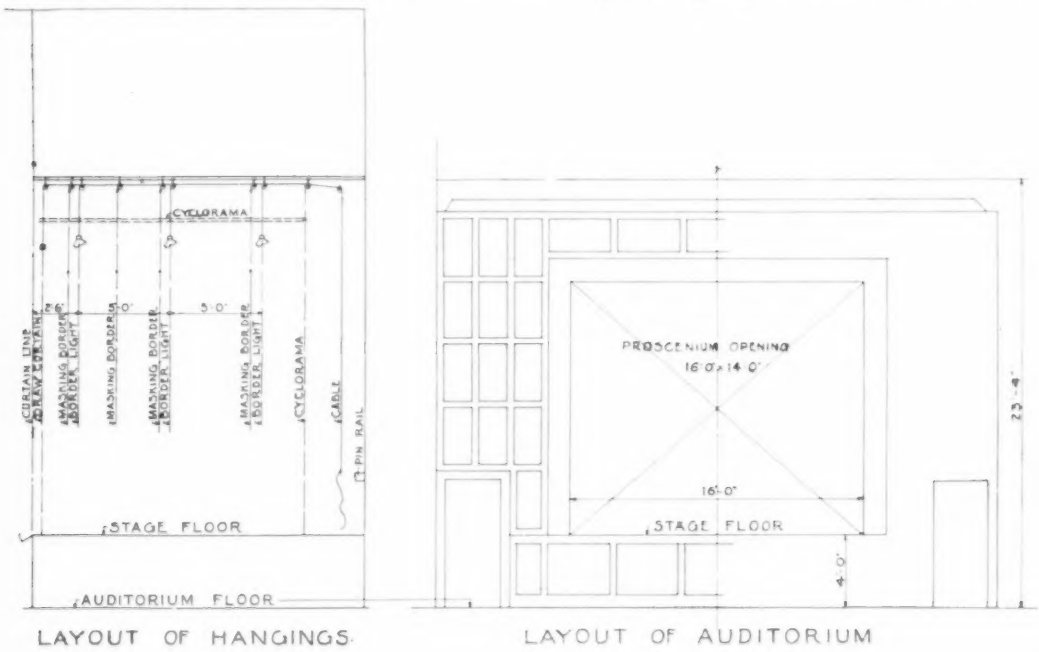


Courtesy of Peter Clark, Inc.

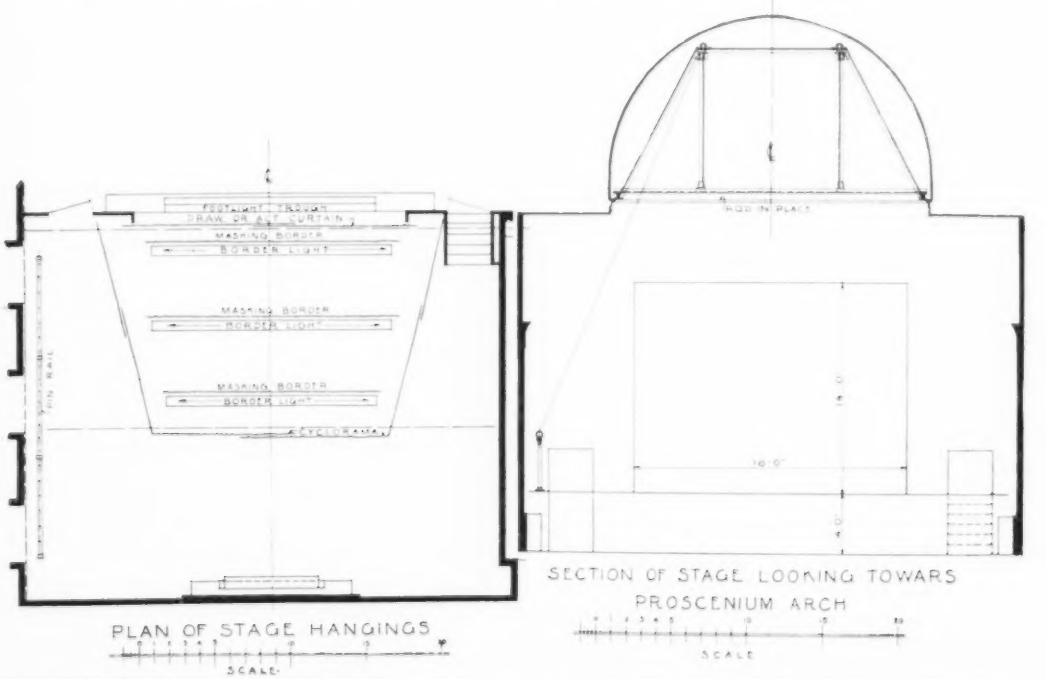
Details of a PROJECTION ROOM on the NEW AMSTERDAM THEATRE ROOF, New York City



a. West Side Branch, Y.M.C.A., New York City; Dwight James Baum, Architect

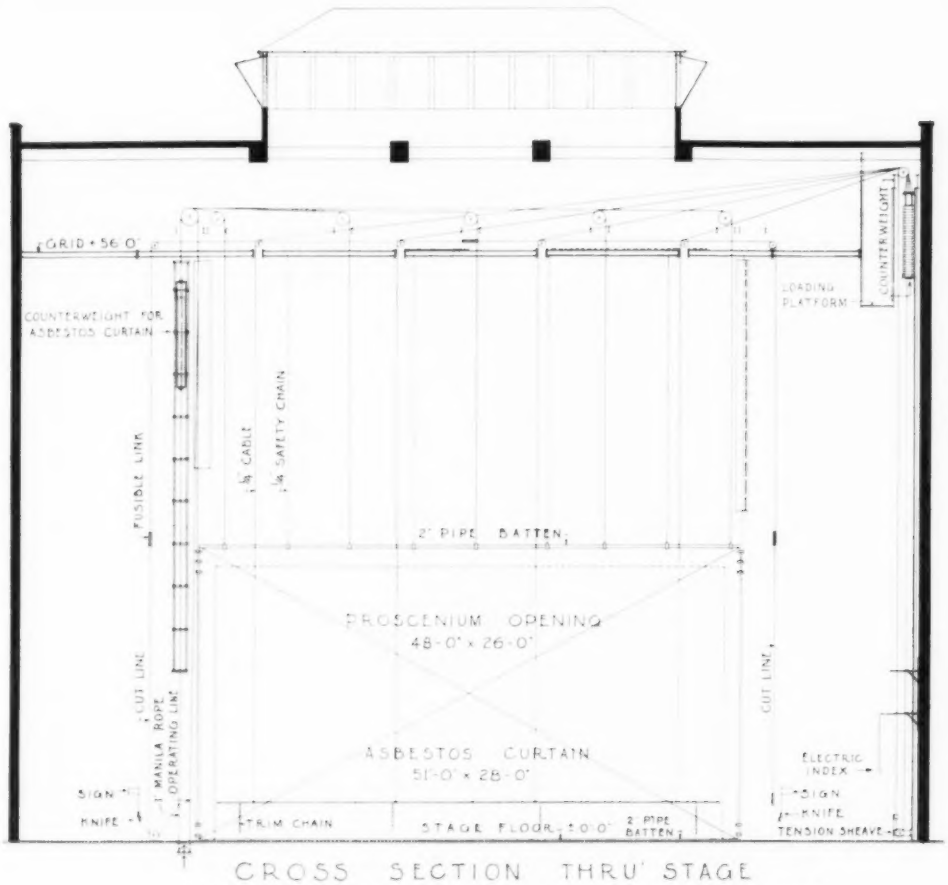


TWO TYPES OF LITTLE-THEATRE STAGES



Courtesy: Peter Clark, Inc.

b. Union College, Schenectady, N.Y.; Peter Clark, Inc., Designer



CROSS SECTION THRU' STAGE
LOOKING TOWARDS PROSCENIUM OPENING SHOWING COUNTERWEIGHT SYSTEM & ASBESTOS CURTAIN RIGGING

LONGITUDINAL SECTION THRU' STAGE

Courtesy of Peter Clark, Inc.

STAGE DETAILS OF A TYPICAL THEATRE

2. DIMENSIONS. The stage is about four times as large as the part that is visible to the audience.

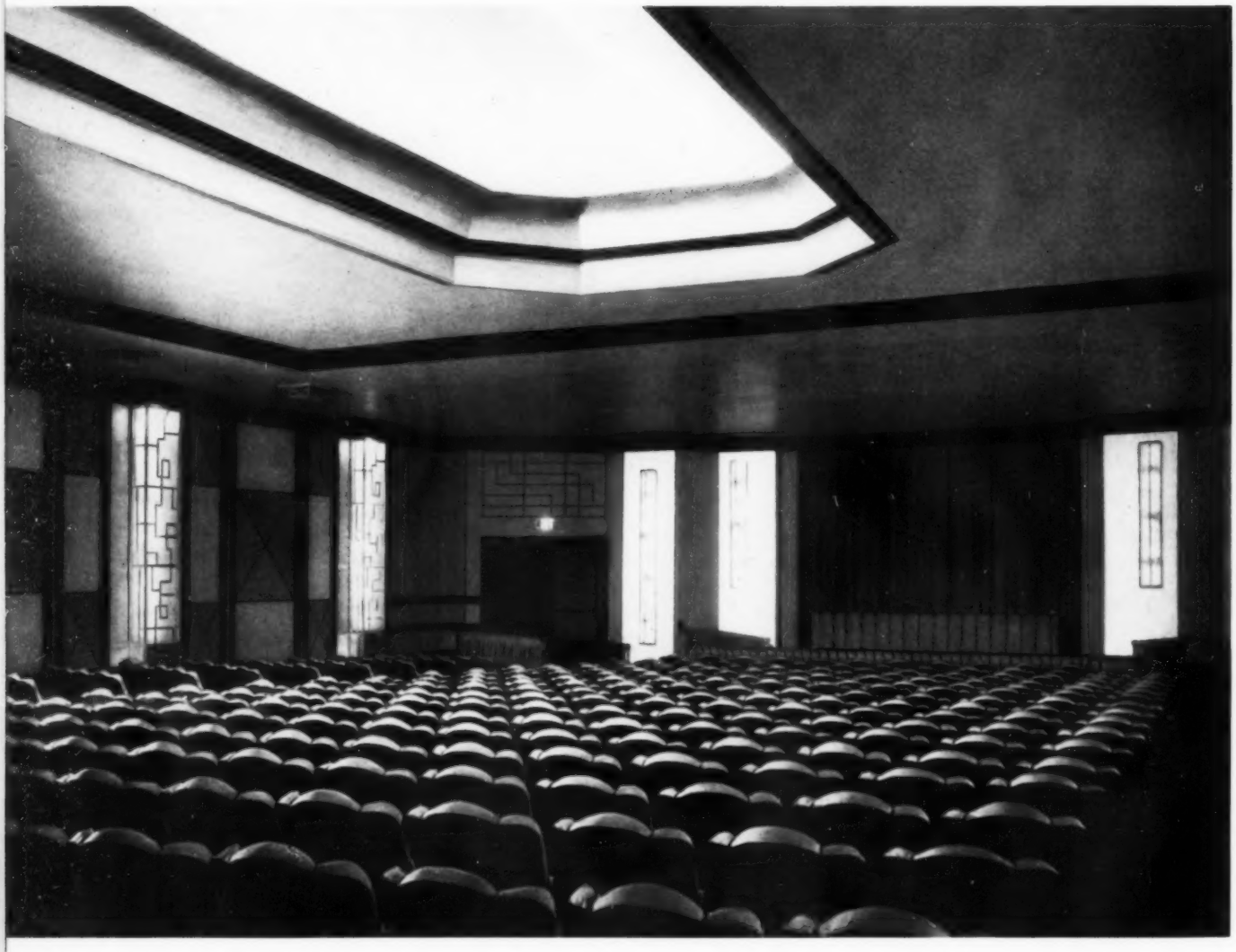
The height of the proscenium should be fittingly proportioned to the width, with a minimum of about twelve feet for small amateur theatres. A stage too low and too narrow will throw the human figure out of proportion to its surroundings on the stage. For the average legitimate stage we may assume a 45-foot proscenium opening (in movie and opera houses it may be larger, depending on size of auditorium. See table) and not less than 35 feet high. A false proscenium may be used to reduce this to scale of scene being used. The aggregate off-stage space right and left should then equal about 45 feet, making the total width of the stage at least 90 feet. The depth of the stage should be not less than 30 feet; 45 is preferable. The height of the stage from floor to "rigging loft" should be not less than 65 feet; more height is desirable.

Typical examples of stage dimensions are given in accompanying table:

		General Dimensions				
		Proscenium		Stage		
		Width	Hgt.	Width	Hgt.	Depth
Amateur	Provincetown	20′	10′	30′		16′
Legitimate	Belasco	35′	20′	55′	60′	30′
Musical Comedy	Globe	40′	25′	75′	90′	35′
Opera Houses		50′	30′	90′	90′	60′

On the next two pages are two views of the LITTLE CARNEGIE PLAYHOUSE, New York City; WOLFGANG AND POLA HOFFMANN, Architects. At the left is shown the entrance; at the right, the picture gallery. The plan includes bowling alleys

CONTINUOUS NOON TO MIDN
THE 10 DAYS THAT
SHOOK THE WORLD
CARNEGIE
PLAYHOUSE
OF DISTINCTION
THE ARISTOCRAT
OF THE CINEMA



AUDITORIUM OF THE LITTLE CARNEGIE PLAYHOUSE, New York City; WOLFGANG AND POLA HOFFMANN, Architects

These measurements, while customary, are not ideal, and are the result of the more or less arbitrary dimensions imposed by high land values.

The off-stage space at the sides is particularly important. Without it, entrances to the scene are cramped, there is no place to pack furniture and scenery for other acts than the one in progress on the stage, and there is no place for the actors to await their entrances. Such space is needed, often, for the suggestion of other rooms than the one before the audience, and an important part of the lighting of the scene is done from the sides.

The best position for the lighting control board of standard size seems to be one on a line with the proscenium wall either on the floor of the stage, or elevated above it so as to be out of the way of the actors and stage workers. However, the latter kind is apt to be a bit inaccessible. Some boards have been placed ahead of the proscenium arch at the side of the auditorium so that the operator can see through an opening what the effect of the lights is on the stage. The operator should, however, be within constant communication with the stage manager.

3. OFF-STAGE FACILITIES.

a. Entrance. It is well to contrive the building so that a central entrance corridor from the street (with door-

SOCIAL ROOM of the LITTLE CARNEGIE PLAYHOUSE, New York City; WOLFGANG AND POLA HOFFMANN, Architects

man's office, time clock, receiving window) controls the access to the stage, the dressing-room corridors, shops, cellar, stairs, and front of the house. When many doors open on the stage, it is difficult to find space for the stacking of scenery without blocking them.

b. Requirements at the stage level.

(1) At least one and preferably two or three quick-change dressing rooms should be located near stage.

(2) Green room about 15 by 25 feet, located on dressing room side.

c. Rooms that may be located on other levels. The following rooms should be grouped together on one or more levels preferably on the side of the stage entrance.

(1) Dressing rooms.

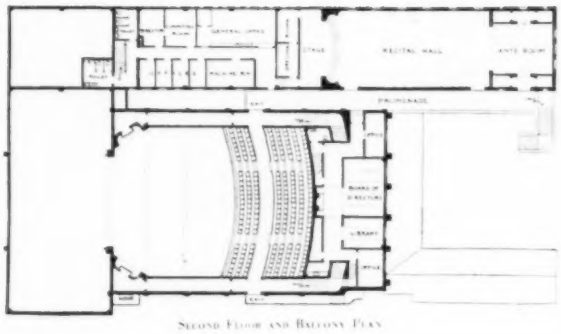
Two or more individual dressing rooms for stars.

From fifteen to forty double dressing rooms for supporting cast. Twenty may be taken as average.

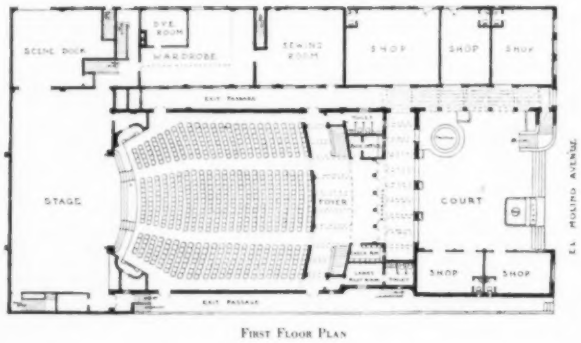
A minimum of two chorus dressing rooms to accommodate twenty actors each. (An opera house should have chorus rooms for 300 people.)

Dressing rooms should contain make-up tables for two actors with mirrors, full length mirror, lockers, wardrobe, drawers, wash basin, and shower baths.

(2) Hair dressers' room should be located conveniently to dressing rooms.

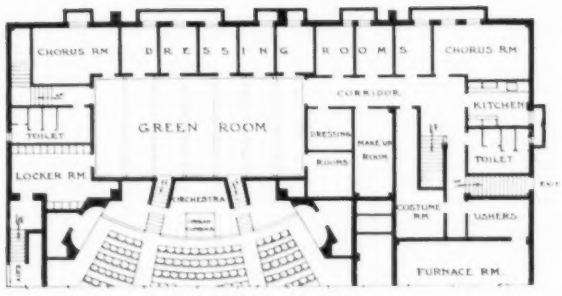


SECOND FLOOR AND BALCONY PLAN



FIRST FLOOR PLAN

PASADENA COMMUNITY THEATRE — ELMER GREY, Architect, with plans showing the arrangement of off-stage facilities.



BASEMENT PLAN

(3) Wardrobe room.

In the ideal theatre two rooms should be set aside for the wardrobe, one for the making of clothes and another for their storage. The sewing room, needless to say, should be well lighted, should have a space partitioned off as a fitting room, should be provided with proper closets in which to hang dresses in the process of making and should be large enough to allow for a number of seamstresses and a large cutting table. There should be a built-in closet equipped with shelves and drawers in which to store clothes, trimmings, and findings, for the making of costumes. For the costume storage room, a loft space that might otherwise go to waste can often be utilized. This room should have long closets, fitted with bars on which dresses can be hung, and should have drawers in which other items of dress can be packed—hats, shoes, wigs, stockings, tights. These drawers should be numerous enough to allow for the sorting out of costumes by colors or periods.

(4) The property department with a shop for the making of furniture, papier-mache, and other property work, and a current production storage room in which furniture and other stage furnishings can be stored. Often one large room can be made to do for both.

(5) Mechanics' rooms.

The remainder of the units, as listed below, may be located according to the individual requirements of the problem.

The office for the stage manager must be close to the stage.

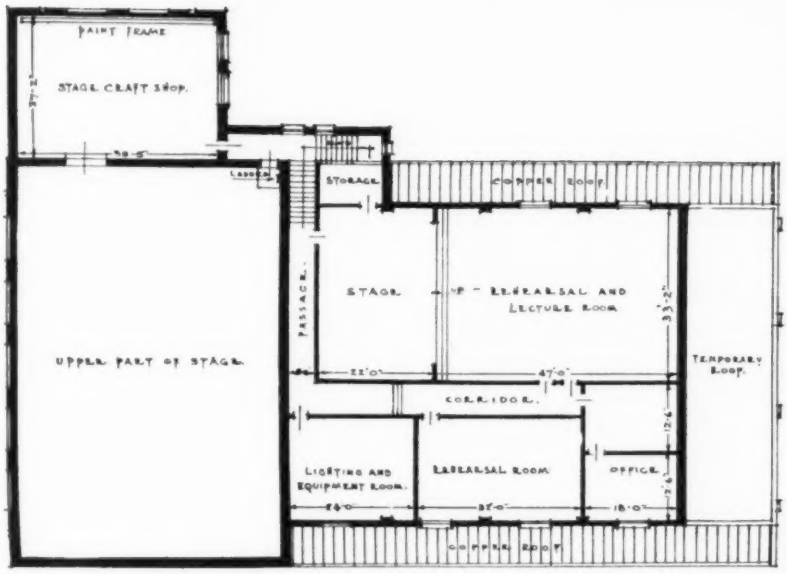
"Each of the mechanical departments should have its two rooms, one a shop and the other for storage.

The carpenter, if the scenery is built in the theatre, often can use the space under the stage (where legal). If he cannot build his scenery there, either another place about 18 by 35 feet should be set aside, or the scenery should be built outside the building. He should not use the stage. It must be kept free for rehearsals. He should, however, have a room in which to keep his tools, draw his plans, and file his ground and framing plans, bills, and time sheets.

The electrical department likewise must not be overlooked. A room about 15 by 30 feet is a good size. There must be closets for the keeping of incandescent bulbs, lamp dyes, plugs, connectors, cable, wire and other electrical hardware, gelatines, color frames, etc. There must be provision in the shop for the dyeing of lamps, testing, repairing, etc."

The scene painters' shop requires a room about 12 by 40 feet and 20 to 40 feet high. The smithy, containing forge, drill, etc., requires a room about 10 by 15 feet.

"The property and electrical departments, like the carpenter's, must also be fitted in a sense as offices, for the keeping of electric and property plots, full records relating to past and coming productions, bills, orders, receipts, time sheets, and similar data.



It may be objected at this point that these various demands presuppose a large-sized plant with elaborate equipment. As a matter of fact, they apply quite as much to the tiniest of little theatres—even more so, for in such, proper ordering or space and isolation of separate activities is equivalent, in getting efficiency, to more ample space less carefully sub-divided. For, inevitably, these various kinds of work must be done in the theatre, and the people who do them must find space here or there for their work, and the things they make must be kept somewhere. Unless each job and each product is assigned its proper corner, the building is soon a clutter of stuff, accumulating dust, getting jostled about and broken. Then we are back at the old, dark, dirty theatre we are trying so hard to improve upon. The provisions discussed above, though they are not on the stage, are very much a part of it, and go far toward making it an instrument of precision.

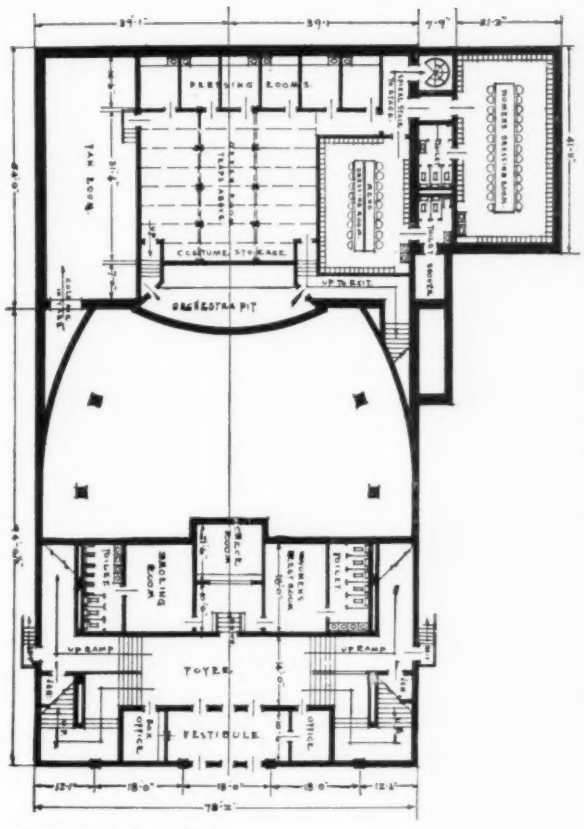
In community buildings and schools, the various workshops, rehearsal room, etc., can often be combined with rooms serving other purposes. In any case some provision for them is quite as important as the open stage itself."[1]

(The number at the end of each quotation refers to the number carried by the book in the bibliography at end of article.)

4. STAGE EQUIPMENT.

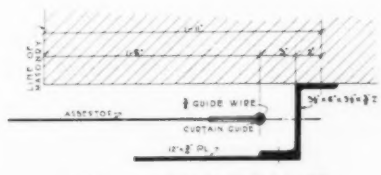
a. Curtains. A fire and smoke-proof curtain must be installed at rear of proscenium opening. It is usually made of asbestos cloth. There are also other types of curtains; a steel and asbestos curtain combined with steel face on the auditorium side and 1" thick asbestos on the stage side. The other and newer curtain now being used extensively is the double asbestos curtain with wire insert on steel channel frame, forming a thickness of 120th part of the curtain width. These three curtains are approved and used in many cities. Some of them are compulsory. They must in all cases be arranged to lower automatically without manual labor in case of fire.

Directly behind the asbestos curtain, an act curtain should be installed. This curtain can either fly, draw or tableau. This can be done with one curtain but the height of the opening governs the complete operation of the three in one. The tableau part of the curtain is principally used for making calls or entrance through the center of the curtain. The drawing is used in the legitimate theatre for cutting down width of the opening, forming tormentor legs which tie up with the



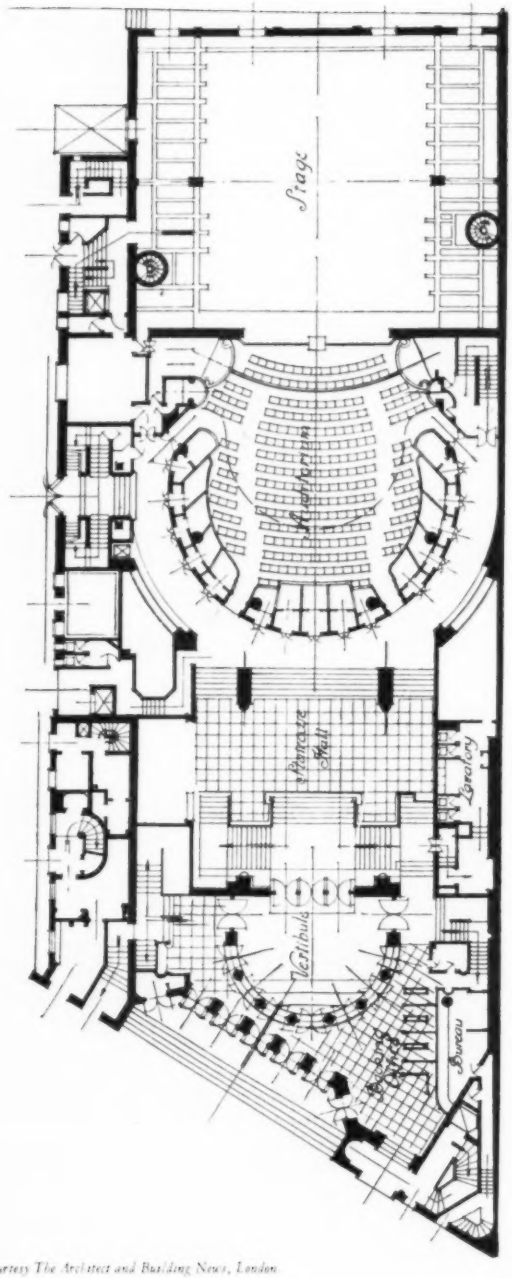
From "Footlights Across America"

PROJECTED THEATRE FOR THE UNIVERSITY OF IOWA, Iowa City; BOYD AND MOORE, Architects. In addition to the well-planned and extensive off-stage facilities shown here, there is a carpenter shop at the stage level.



DETAIL OF SMOKE POCKET

A STANDARD INDICATION OF THIS REQUIRED FEATURE



Courtesy The Architect and Building News, London

The THEATRE PIGALLE, Paris; CHARLES SIDIS, JUST AND BLUM, Architects

"The stage is over 70 ft. wide and 68 ft. deep, and it is so arranged that four complete settings can be shown in rapid succession. This is arranged by a system of two stages, one below the other, the upper of which can be hoisted into the flies complete with its setting, leaving the lower one in position at proscenium level. Each of these stages is also divided transversely into two sections of full width but half depth, so that if desired each may contain a set. As each section is independently controlled, the settings can be mounted and then interchanged with great rapidity."—The *Architect and Building News*.

valance directly in front of the proscenium and in front of the asbestos curtain. The up and down motion of the curtain must be very fast and it must operate easily.

b. Screen. The screen should be located 7 or 8 feet back of the curtain line and the bottom not less than one foot above the stage. Screens are not of exactly the same proportions, due to the angle of projection, but are roughly of the proportions 1 x $1\frac{1}{3}$. The distance from the projector has no bearing on the size of the screen. In providing space for screen it is well to bear in mind that with improvements and new developments in the movie industry it is very likely that new screens of greater size may be used in the near future. The "Grandeur" screen in Roxy's Theatre, New York, is 40 feet wide by 28 feet high.

TABLE OF SCREEN SIZES

Theatre	Capacity	Size of Picture
Roxy (New York City)	6200	24′8″ x 18′6″ (40′ x 28′ Grandeur)
Fox (Detroit)	5046	21′2″ x 17′1″
Fox (St. Louis)	5038	22′0″ x 17′8″
Fox (Brooklyn)	4100	20′0″ x 15′7″
Fox (Washington)	3400	20′0″ x 16′0″
Fox (Philadelphia)	2446	18′0″ x 14′5″
Locust (Philadelphia)	1580	18′0″ x 13′6″

c. Scenery Equipment.

"Scenery is of two types: pieces that are suspended from ropes (hanging pieces), and pieces that stand on the floor (set pieces). For exterior scenes, the first type includes drops, 'borders' representing foliage, leg-drops, trees, pillars, and arches or sections of wall, house-front, or other flat architectural units, large enough to warrant hanging overhead when out of use, so as to save floor space; and—for interior scenes—ceilings and back walls. The second type includes, for exterior scenes, any low-standing units, such as walls, hedges, fences, tree trunks, 'wings' or set-houses; and for interior scenes, the side-walls of the room and very often part or the whole of the back wall.

The matter of storage space for scenery is to be determined wholly by the amount of space at the builder's disposal and the use to which the theatre is to be put."[1]

Scenery is usually built to go through a box car door (5′9″ x 8′6″). Larger pieces are built hinged or in sections.

1. SCENE DOCK. If many productions are to be made, a space to accommodate such pieces standing on end should be provided for in a scene dock, adjacent to the stage but separated from it by a wall and fireproof doors. Scenery should not be allowed to accumulate on the stage. The theatre of the Carnegie Institute of Technology at Pittsburgh has an excellent dock.

2. LOADING DOORS. Loading doors which will accommodate any standard size scenery should be provided directly from the stage to the street or alley. These doors should have following dimensions:

Minimum—7′6″ x 8′6″
Legitimate house—12′0″ x 18′0″ (high)
Opera houses—16′0″ x 30′0″ (high)

3. GRIDIRON. For the manipulation of hanging scenery one of the most important parts of the stage is the steel gridiron. This is made of steel channels and I-beams with 3″ channel or flat iron floor laid over I-beams for walkway. This should be 55 feet to preferably 65 feet above the stage floor in the average theatre.

The space underneath the beams supporting the roof to the gridiron floor can be as low as 5 feet. The gridiron mentioned above is arranged with slots for lines designed for the various width openings. Openings from 30 feet to 35 feet would be a 3-line opening; 37 feet to 50 feet would be a 4-line; 50 feet to 60 feet would be a 5-line opening; where openings are greater as in auditoriums, they average up to 6, 7, 8 or 9 lines as in the auditorium at Atlantic City. The spacing of slots in the gridiron can be as wide as 14′6″ and the best average is 13′0″. These lines, needless to say, should be of the best grade manila rope.

The ends of these lines in each set are brought together at one side or the other of the stage, so each set may be operated as one. On the side to which the lines are led is located the pin-rail, either on a fly-gallery or at the floor level.

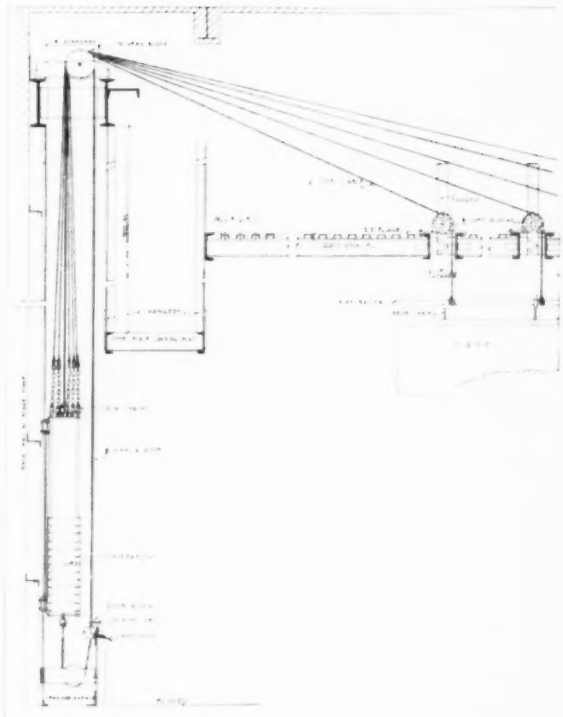
4. COUNTERWEIGHT SYSTEM. In newer theatres, large or small, the tendency of the day is to use the counterweight for handling scenery. This method is quicker and safer than any other yet developed for hanging drops, flats, wings, ceilings, and everything that is flown on the stage. In most cases it eliminates the fly gallery and brings operations to the stage floor. Signal systems are replaced by the *locking rail* from which scenery is released, each line having a card index system of its own. The two types of counterweight system—one with steel tee bar rails, the other with a wire guide—are entirely alike except as to guide rails.

The counterweight frames for the larger theatres run up to 12 feet in length, and for smaller theatres up to 6 or 8 feet, giving sufficient space in each case for equally balancing the drop, border lights, lightest curtain, or heaviest flat, without any interchange of weights. The weights principally used in the counterweight system average 10 lbs. to the inch. They are 3 inches wide, and 1, 2 or 3 inches deep, weighing 10 lbs. for every inch of depth.

The depth of the cellar (*sink*) depends on the type of equipment used to change the sets. If the stage is of the usual type with traps, the finished floor height may be 9′ 6″.

If the stage is equipped with electric or hydraulic elevators (*bridges*) the sink may be from 30 feet to 40 feet below stage level. (In this instance, if there is to be a *one-basement level*, the excavation should be deep enough so that the elevator or stage trap when it is down comes flush with the basement floor.)

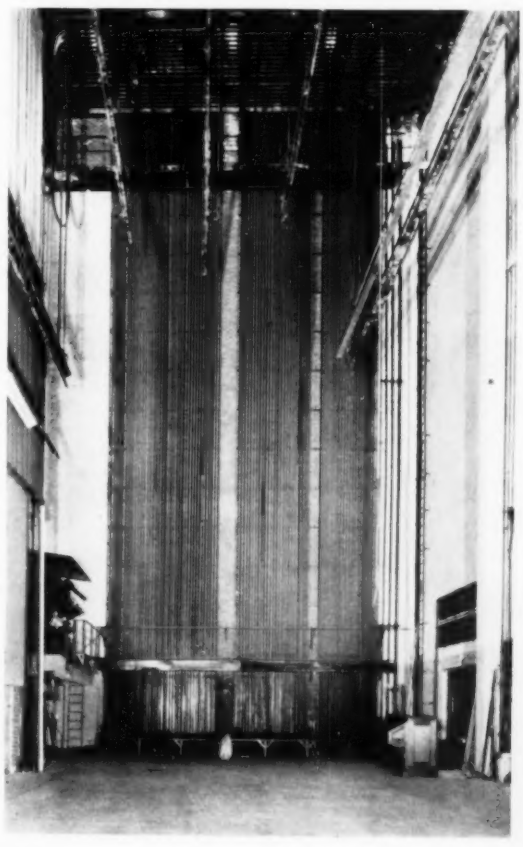
If a plain revolving stage is used, there must be room enough for the machinery as well as access to the traps (10 or 15 feet).

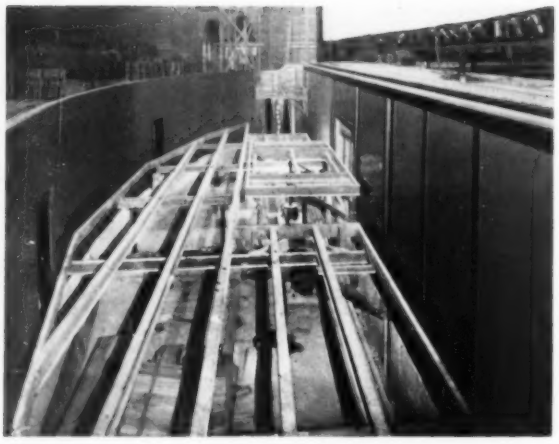


Courtesy Peter Clark, Inc.

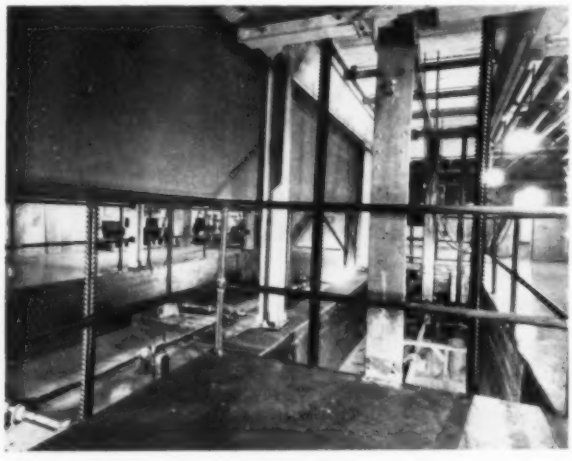
Above: Essential Details of a GRIDIRON AND COUNTERWEIGHT SYSTEM. (See text at left)

Below: COUNTERWEIGHT FRAME in the Temple of the Scottish Rite, Philadelphia; by PETER CLARK, INC.

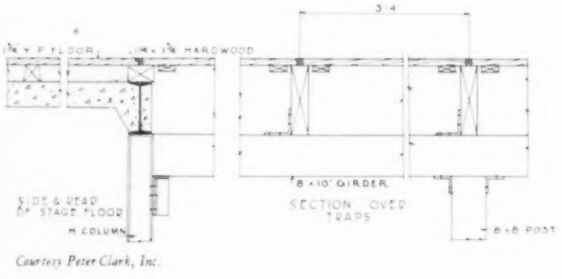




FRAMING of Three Elevators in Orchestra Pit Fox Theatre, Atlanta; JOHN EBERSON, Architect (See text at right)



ELEVATOR SHAFTS in Basement of Fox Theatre shown above (See text at right)



Courtesy Peter Clark, Inc.

TRAP DETAILS McCarter Theatre, Princeton University; FISHER, Architect. At the left is shown the floor construction at sides and rear where there are no traps; at the right, construction over traps.

Traps should be provided covering about three quarters of the area of the stage proper, and should extend on the sides at least to the lines of the proscenium opening. These traps are usually about 3′ 6″ x 6′ 0″.

The trap room should be open under the entire working part of the stage (the part on which the action takes place).

Elevators. Often, especially in large theatres, stage elevators (called *bridges*), are installed. These are sections of the stage which may be mechanically raised or lowered. In large movie houses an elevator is sometimes installed on which the screen and loud speaker equipment are built. This is lowered into the stage when not in use.

Elevators of a similar style may also be used to raise and lower the floor of the orchestra pit, the organ console, and the piano. These may be individual elevators or may be combined into two or one. The console elevator is sometimes constructed as a turntable.

Under the Stage. Musicians' room, with access to the orchestra pit, containing lockers and a toilet.

Orchestra Pit. The orchestra pit should be arranged so that the rail may be removed and temporary seats installed when desired.

5. STAGE LIGHTING. For the first time in the history of the theatre, scientific principles of illumination design are being employed on the stage, and lighting equipment based on accepted standards of efficiency and sound engineering practice is being substituted for obsolete methods long discarded in other fields of lighting.

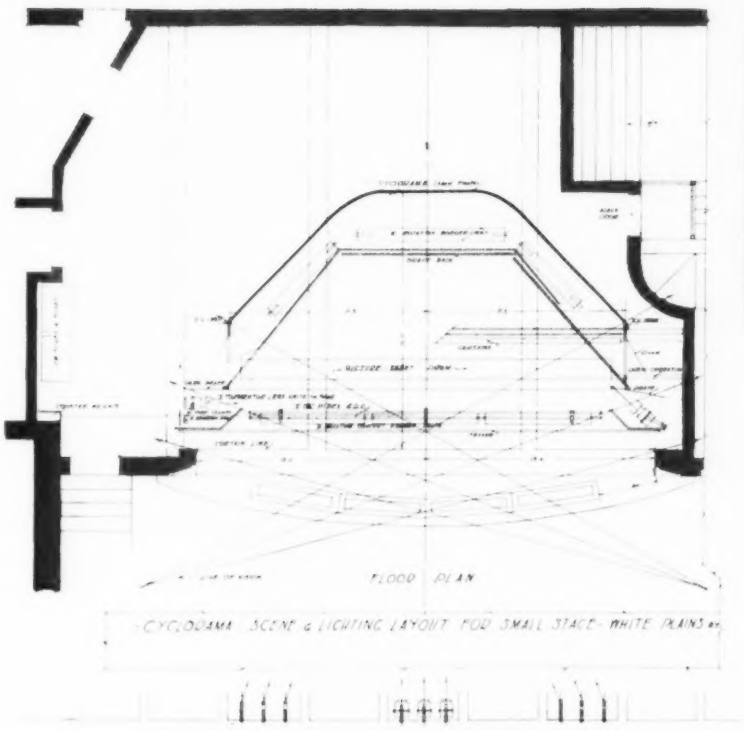
As many theatre stages and practically all high-school and college stages are not designed for proper lighting, it is not safe to base lighting provisions on existing jobs or some of the lighting equipment now on the market. The recommendations of electrical engineers, unless they have had considerable experience with actual lighting of plays *in the finished theatre*, should be carefully checked by someone thoroughly acquainted with stage lighting problems. On this point S. R. McCandless of Yale writes:

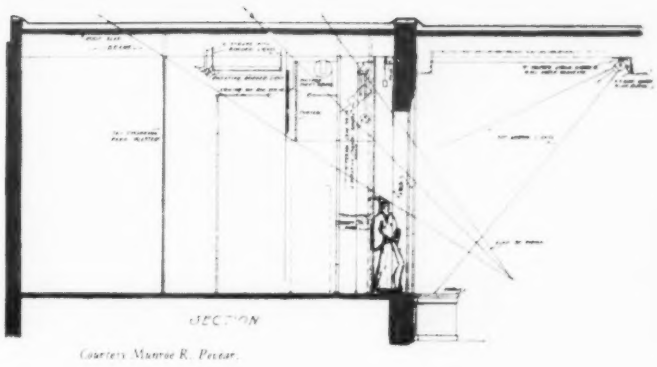
"Until the architect knows enough about lighting and the engineer knows more about architecture and theatrical production, some designer who knows the problems of both (a kind of theatrical lighting architect) should be employed in connection with every job. When you consider the amount of money that is being spent on decoration, on mechanical equipment and other elements which promote comfort and beauty, it seems strange that the architect should be willing to limit its effectiveness by an ignorant use of light.

"Another point I think you should make very definitely is that just as we are using more plumbing and sacrificing exterior to that end, tomorrow we will be using light much more extensively than we now think necessary. Unless provisions are made for this when the building is in the process of design, the poor conception of the architect will go limping through life always incomplete."

a. Principles Governing the Design of the Lighting Layout.

"The structure of the building must lend itself to putting different types of instruments in almost any position. These instruments





Note the APRON LIGHTS (in section at right) attached to the ceiling; note that FOOTLIGHTS (in plan at left) are kept 4 feet from sides of proscenium arch. The drawings are of small stage for amateur theatricals included in the WESTCHESTER COUNTY CENTER, White Plains, New York; WALKER AND GILLETTE, Architects

should be easily hung and well concealed from the audience so that the mechanics of lighting are not obvious.

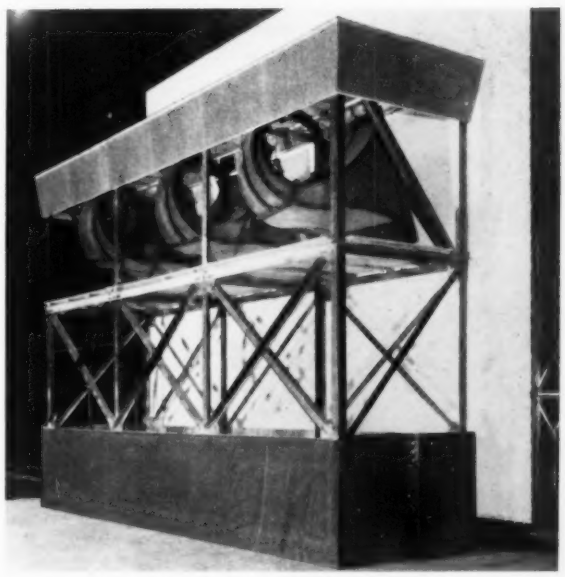
"Lighting equipment should be portable so as to be useful in a number of places. This necessitates standardized hangings and connections."[2]

Even footlights, cyclorama lights, etc., though designed for a definite use, might be portable, as the space they occupy may be needed for other purposes.

Outlets should be installed at convenient positions to serve a reasonable number of lighting units in many locations. These outlets should be regular plug pockets or 15 ampere female pockets* with a connector at the end of a short pigtail. These outlets should be grouped in fours where colors might be used. Provision must be made for installation of light bridges, pipe battens, stands, and portable bridges, on which to mount the various instruments. The instruments should be equipped with pipe clamps and swing joints to allow easy hanging in any position, and focusing in any direction.

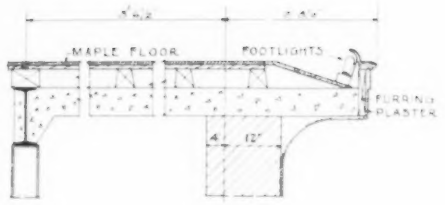
b. Location of Instruments for the Average Theatre. Stage lighting instruments are best classified by their location and use rather than by differences in the lamp or fixture. For example: footlights may be open lamps or groups of reflector units. A group of focusing lense units (popularly called spot-lights) may be called foot, border, teaser, tormenter or cyclorama lights, depending on the location. Technically any focusing lens manually *operated to follow a character around the stage* is called a spotlight.

Originally footlights were used to illuminate the actors; but with the introduction of various spot- and border-lights, the footlights have come to be used largely to lighten shadows and tone up the scenery. In presentation houses they are used extensively to light the

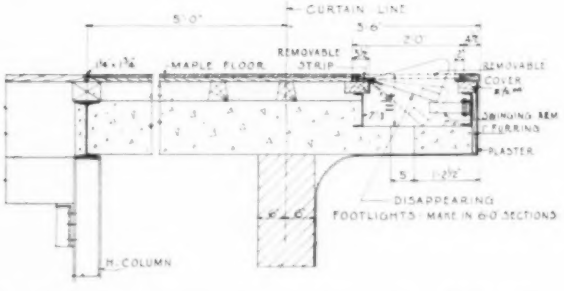


SOUND AMPLIFIERS, Fox Theatre, Atlanta; JOHN EBERSON, Architect. This installation must be directly behind the screen, or the acoustical effect is thrown off. This one has an elevator of its own

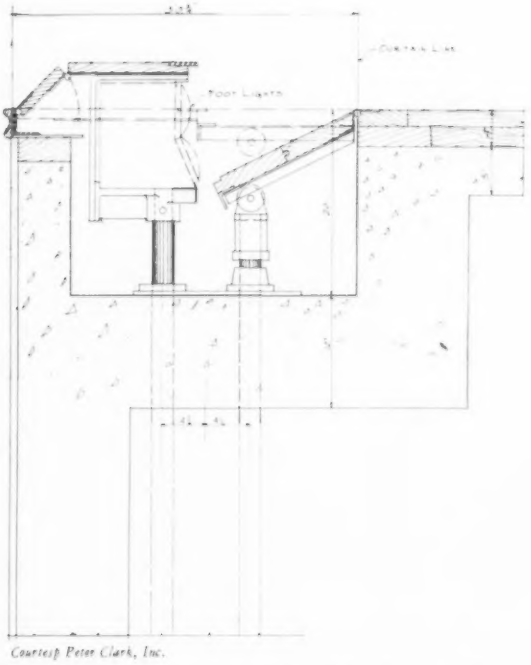
*Not always permitted by local code.



TYPICAL FOOTLIGHT DETAIL



Detail of DISAPPEARING FOOTLIGHT, McCarthy Theatre, Princeton University; FISHER, Architect



Courtesy Peter Clark, Inc.

DISAPPEARING FOOTLIGHT for Mastbaum Theatre, Philadelphia.

chorus girls. The illumination of the actor now comes largely from focusing lenses from the face of the balcony, or from projection booth, auditorium, ceiling, light bridge, or wings. The accompanying sketch shows how an actor is lit by different groups of lights as he progresses from backstage to front stage. The light must be even everywhere on the stage, and must nowhere cast unnatural shadows on the face. "Soft-edge" lenses focused from the ceiling of the auditorium at a 30-degree angle to the vertical are needed as the actor moves forward out of range from the teaser lights.

c. Footlights. For satisfactory performance, the footlights must fulfill the following requirements: (1) the filament of the lamp bulb should be above the stage floor level; (2) the top of the reflector should not project above the floor more than four and one-half inches; (3) the light rays from colored bulbs or light reflectors using color screens must overlap sufficiently to secure mixing of the colors close to the footlights in order to avoid a "Scotch plaid effect"; (4) the wattage used and spacing of bulbs or reflectors will depend on the size of theatre and size of stage; (5) the installation must be kept 5 feet or more from the sides of the proscenium opening, to prevent objectionable reflection from the proscenium wall; (6) footlights can be installed in three or more removable or disappearing sections; (7) they should be wired for three or four colors, and controlled in center and end sections; (8) the light should all fall within the proscenium opening.

The footlights are commonly arranged for three colors, each color separately controlled. These may be colored bulbs or clear bulbs with color screens, and may be arranged in single or double rows.

d. Light Bridge. Should be built approximately 6 feet shorter than the proscenium opening is wide, having two battens underneath and mounting pipes on the hand rail. Hung up-stage from act curtain. The bridge should have 12 to 24 outlets and 2 to 4 arc outlets.

e. Tormenters. Six to 12 outlets are desirable on each side of the stage with permanent ladder to permit adjustment.

f. Border Lights. Borders are generally 4 to 10 feet less in length than the width of the proscenium arch. They are spaced 6 to 8 feet apart, and good practice is to have one work light at each end of each border. One hundred to 125 watts of Type C lamps in each color are provided for each lineal foot or border.

First Border. Four feet shorter than the proscenium arch at each end and hung on a pipe batten hung from strain insulators. Fed by cable suspended from the grid.

Second and Third Borders. These are 2 feet longer than the proscenium arch, and supported the same as the first border. Fed by cable suspended from the grid.

Provision for Additional Borders. Four to 8 outlets on the grid, spaced so as to be accessible for lights to hang back of the third border.

g. Cyclorama Lights. Several high-power circuits to supply whatever type of cyclorama lighting is used. Fed by cable suspended from the grid. Also stage pockets properly located for illumination for the bottom of the cyclorama.

Floor Pockets. Four to 9 (four-outlet) floor pockets, spaced along the sides and rear of the acting area. Also two to four arc pockets on each side of the stage.

Balcony Rail. From 4 to 12 fifteen-ampere outlets.

Apron or Beam Lights. Provision should be made for from 4 to 12 beam lights in the ceiling of the auditorium. They should be at an angle of 30° with the intersection of the curtain and stage lines. Access to these beam lights may be had in the space between the hung ceiling and the roof or by portable ladders in small auditoriums.

Work Lights. Can be attached to any of the existing circuits or run independently for stage area, switchboard, pin rail and prompt board, orchestra lights.

h. Control Board. The control board in a rental theatre is a comparatively simple affair. It generally provides control only of auditorium lights, footlights and the first border lights. *A large company switch of 1000–2000 amperes is always provided* to serve the portable boards that each company brings with it.

In the professional theatre a special board is built for each production, and tapped into the main service as a control for practically all the lighting in that particular show.

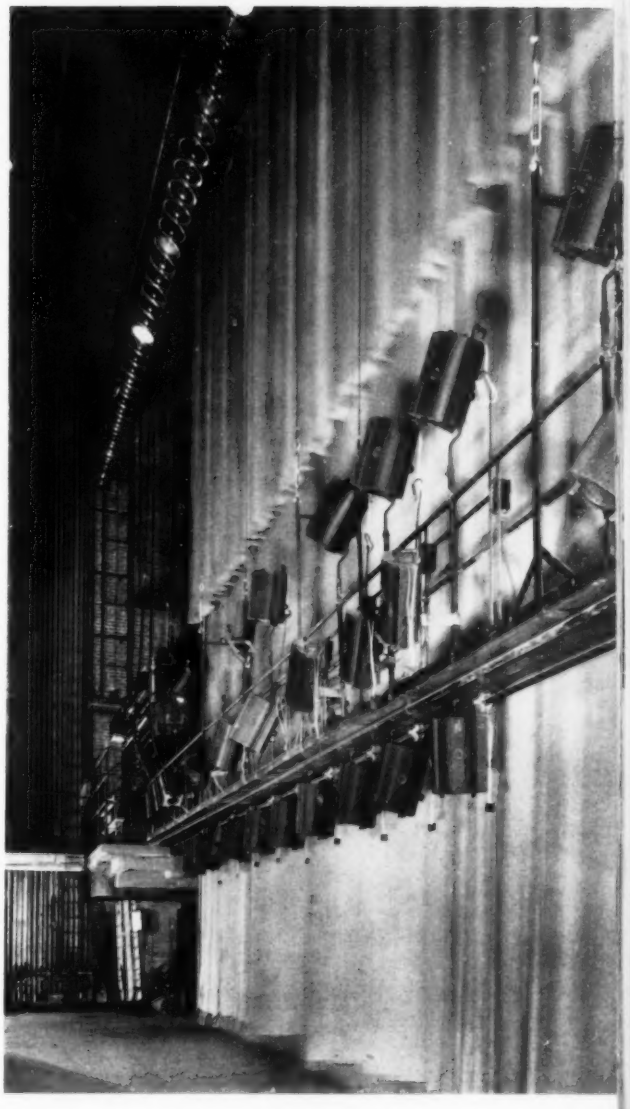
In the producer-owner theatre (community, repertory, school, or movie) this portable board becomes part of the permanent equipment of the stage.

The following principles should be considered in designing a control board:

1. CENTRALIZATION OF CONTROL.

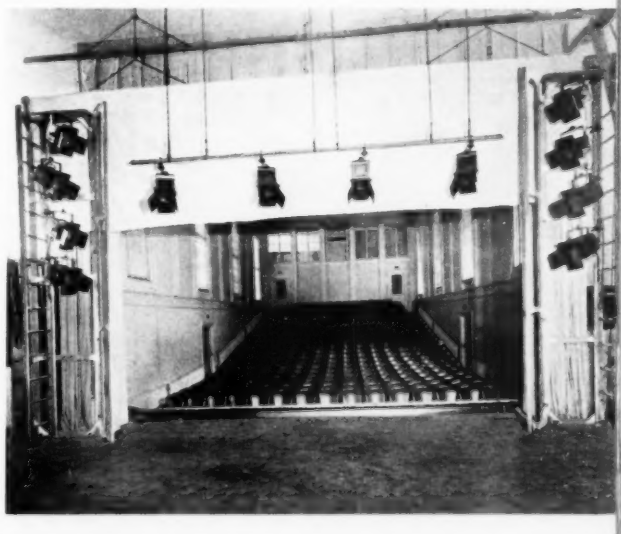
"The important consideration is that, so far as possible, each light unit on the stage shall be subject to central control from a vantage point from which the stage can be seen; that each unit shall be subject to separate control; that groups of like units, classed by location or color, shall be subject to group control, apart from other groups; and that the stage lights, as a whole, shall be controllable apart from the house lights.

"That is, assuming, for purposes of illustration, the arrangement of lights common to most theatres, the white lights of the first border shall be controlled by a switch apart from that controlling the white lights of the second border or the third or the fourth. So, likewise, for each color circuit of each border, separately. There should be a white border main switch, controlling the white lights of all the borders, and a blue border main, etc. Above these, there should be a border main switch controlling all the border lights simultaneously. And thus with each division of the stage lights. Over all, one stage main switch should control all the lights of the stage. The auditorium lights, with their own switches, should be controlled from the same board as the stage lights.



LIGHT BRIDGES large and small. *Above* is the installation in the Temple of the Scottish Rite Philadelphia; designed by PETER CLARK, INC.

Below is a little theatre installation at the University of North Carolina



FOX THEATRE, Atlanta; JOHN EBERSON, Architect. Showing balcony, orchestra seats and musicians' pit with elevator down, giving access to backstage door

"So far as possible, there should be a dimmer for each switch on the board, controlling each light unit separately. With 'master' levers related light units can be gauged and controlled simultaneously."[1]

The present board with all master controls within easy reach near the operator simplified the problem tremendously.

2. PHYSICAL EASE OF OPERATION.

"Compactness, to come within the easy reach of the operator and to allow for placing the board in such a position that the effects on the stage can be seen by him, is limited by the size of parts, by electrical spacing, dimmer spacing, interlocking and interconnecting apparatus. But the invention of remote control by contactor switches and pre-set devices on the dimmers allows considerable condensation. Single pole switches, multi-capacity dimmers, interlocking and interconnecting devices permit an elimination of many units.

"All parts under the control of the hand should be as frictionless as possible. Their size should be related and spaced with regard to *finger manipulation rather than for the hand*. Motor and remote control, which allow for the work to be done mechanically or electrically, have solved the problem somewhat.

Below: Three sets of BORDER LIGHTS with three curtains for successive playing depths of stage.

3. CLEARNESS AND SIMPLICITY.

"The unit (switch, pilot light, and dimmer) combinations with all parts directly related to one another and with adequate markings as to wattage, amperage, location, use, etc., make a very simple board to operate. Interconnecting, grouping and dialing of dimmers allow for massing color combinations. Pre-set dimmers and switches permit single movement master control."[2]

4. FLEXIBILITY. A thoroughly flexible board allows the interconnecting and grouping of light units of varying size in any position on the stage to any dimmer or group

of dimmers. It is less expensive, takes up less room, allows for a greater number of combinations, and is easier to operate than a board on which all the circuits are wired solidly to definite switches and dimmers. But such a board requires absolute accuracy in making a particular set-up.

k. Dimmers. The outstanding item of expense in building a good control board is the cost of *dimmers*, the resistance devices by which the intensity of the light is controlled. They vary in capacity with their wattage and type. The dimmers, more than any other part of the control system, contribute to the range of lighting effects. In a modern theatre they are indispensable.

Signal System. "On account of the size of the ordinary theatre building and the necessity of dispatch in the performance, a prompt-board is necessary with communication to all parts of the stage, the dressing rooms and the building. Light signals (with a return flash to the switchboard, curtain pull, the pin rail, sound cue positions, and such other places as are important for time cues) should be mounted above the desk on which the stage manager has his script. Dressing room call signals, or a loud speaker, an act call bell which announces the beginning of an act, and an intercommunicating telephone to all parts of the building can be mounted alongside the flash signals. The prompt-board should be as close to the proscenium as possible or better under the front of the apron, as one finds in the continental theatre."

"The unconscious effect of the light in a scene can be destroyed if the audience senses the mechanics. Snap switches, noisy dimmers, squeaky interlocking devices, should be eliminated. Spring stops on the dimmer, and knife blade switches or contactors, well housed, help to accomplish this end."[2]

l. Projection Booth. The projection booth should be on a separate floor above the balcony. It must be of fireproof construction throughout. The floor must be substantially constructed to support the projection machines and to avoid vibration. The projection and observation ports must have tight fitting gravity shutters that close automatically in case of fire. The booth must be provided with adequate exit facilities for the operators in case of an emergency. All doors should be of the automatic self-closing type. Adequate ventilation is mandatory.

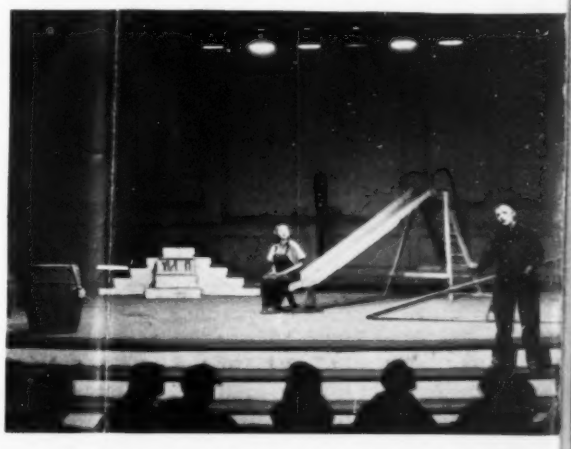
"It is essential that the port holes be of correct size and location. 'The architect should get his specifications from a firm dealing in projector equipment.' Four types of ports should be provided: observation, projector, stereopticon and spotlight. Observation ports for operators are usually about 15 inches square with the center of the opening 5 feet above the floor. Projector ports are 12 inches square, and the stereopticon port about 8 inches wide by 15 inches high. The centers of these openings should be approximately 4 feet above the floor of the projection room. The exact height of all openings in the front of the booth depends upon the angle of projection [see page 467] and the layout should be carefully studied. The spotlight requires a port at least 18 inches high and 24 inches wide. Its centre is located about 4 feet 6 inches above the floor. In a horizontal direction projector ports are located about 4 feet on center. Since the machines used in the projection room are standardized as to size, the incorrect location of the ports produces unsatisfactory results and a condition difficult to correct."[3]

Ordinarily a booth requires ports for at least one spot light, one stereopticon, 3 motion picture machines, and

From "Footlights Across America."

COLLEGE PLAYERS start a good deal going. They perform at improvised theatres in the country. (Cornell University Players at the Syracuse State Fair, N. Y.)—

THEY CARRY good drama where very little went before. (Carolina Playmakers on tour)—



THEY EXPERIMENT with any materials at hand. (A play with "Constructivist" setting at Vassar) Their activities result in the building of many "little" theatres, where big commercial ones would not go.

METHOD OF ANALYZING A FINANCIAL SET-UP

Job No. Location New York City

Land Costs
- Fee Ownership
- Brokerage commission
- Cost of possession
- Carrying charges if any from date of purchase to date of commencement of demolition

Total Land Cost

Construction Costs
- Theatre—(figure on fine const. 55c cu. ft.)
- Commercial—(figure on fine const. 65c cu. ft.)
- Architects fee 5% on above
- Furnishing & Equipment

Total Cost of Const.

Financing Costs
- Financing bond issue—cost 10 pts.
- 1 pt. expenses
- Carrying charges—12–18 months
- Taxes during construction
- Interest at 6% (less 4% interest on deposited monies)
- Rent (if part leasehold)

Total Financing Cost

Total Land, Bldg. and Financing Costs
- Bond issue
- Cash Equity (25%)

Theatre Overhead
- Mortgage Interest 6%
- Amortization 3% on bond
- 6% on cash invested
- Taxes
- Insurance
- Rent (if part leasehold)

Total Theatre Overhead

Commercial Income
- Stores
- Offices

Total Commercial Income
- Operating Costs (runs from 60c to $1.00 depending on type of building)
- Management Fee
- 10%—15% vacancies on offices only (depending upon renting conditions of town)

Deduct Total Commercial Expenses

Net Commercial Income

Theatre Overhead

Net Commercial Income

(Seats in House)

House Scale times

% attendance per day times

Number days per year equal

Total income from theatre

Production Costs

Income from Theatre*

Profit (Income from theatre less overhead)

This will determine whether project is a good investment. If not a good investment the whole set-up is revised, plan altered, a less expensive construction used, or a less expensive land selected or project abandoned.

* (Estimated by theatre manager or owner from architect's sketch considering location and production costs.)

3 for observation. Where the equipment consists of 3 spot lights, a stereopticon, and 3 projectors, a room at least 12 feet by 30 feet is required. Ample working space is essential to the operation of the machines by the operators, who must often work quickly and unhampered.

Adjacent to the projector room there should be provided a work room (for rewinding) about 6 by 7 feet, which should contain a substantial work bench and a fireproof cabinet for reels. There should also be a rheostat room about 6 by 11 feet and a battery room about 5′ x 7′ 6″ which is necessary for sound pictures. A small room should adjoin the projection room for motor generator set if direct current is not available and must be transformed from alternating current. Wash room and toilet facilities should also be provided for attendants. Motor generators are best located in basement in that way eliminating noise and vibration.

ECONOMICS

The importance of the architect's knowing something of the economics of theatre design is apparent when one examines the methods generally followed in promoting a theatre project. For example: from the accompanying method of analyzing the financial set-up, as used by one of the leading theatre owners of the country, it will be noted that the decision as to whether the cost is in proper relation to the site and probable income *is not made until after* the architect has prepared his *preliminary plans*. If the architect in cooperation with the owner makes a preliminary financial analysis before preparing plans, much waste of time will be avoided.

Generally speaking, the theatre building and land may cost twice as much per seat as total gross income per seat per year. But there are so many variables in a theatre project that each case requires its particular analysis and solution. A scheme found to be a good investment in one locality may be a losing one in another. However, analyzing the problem as shown, and estimating the project, on the basis of the box office returns (determined by what the traffic will bear), the architect can then intelligently sketch out his preliminary plans, and the owner may determine from these whether the investment will be profitable.

From a study of several community theatres it is apparent that the total yearly income received will not exceed approximately one-half (average attendance compared to total capacity) the house scale for approximately 275 performances. If the house scale averages a dollar per seat the gross yearly income received will be ½ x $1.00 x 275 equals $137.50 a year per seat. From analysis of production and operating costs it is apparent that the cost of the theatre project may be approximately two times the gross yearly income, or in this case the cost including land may be $275 per seat. (This particular community theatre cost $370 per seat; the difference is made up by subsidy.)

From an analysis of several neighborhood movie theatres it is apparent that the gross yearly income

received is generally not over 1½ times the house scale. Therefore, if the seat price of a neighborhood theatre were thirty cents, the gross yearly income received would be 1½ x $.30 x 365 or $164.25. The total cost of land and building should not exceed 2 x $164.25 or $328 per seat.

For a movie in the heart of the city a seat will be occupied on an average of two times a day. If the average seat price is seventy-five cents the total gross of the seat will be 2 x $.75 x 365 — $547 and the cost of the theatre per seat for land and building approximates twice this sum or $1,095.

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SPECIFICATION CHECKING LIST

The Theatre Specification and Checking List on the next page, by A. D. Hill of Hodgens and Hill, Architects, was received after the index had been printed, and so will not be found in the Table of Contents. It nevertheless is an important part of the study, and will repay careful perusal.

IMPORTANT NOTICE

The *Auditorium Requirements in the Theatre* are to be treated in a special, separate "Technical News" study in July issue of the ARCHITECTURAL RECORD There have been extensive innovations in acoustics and lighting too important to be summarized briefly in a general study such as this; particularly interesting are the several experiments in "painting with light."

THEATRE NEIGHBORHOOD HOUSE—"A"

1350 Seats—average price of ticket $.30

	Cost	
	Total	*Per Seat*
Land	$ 90,000	$ 66.6
Building	130,000	96.3
Equipment		
Electric Sign	3,000	2.22
Decorations	3,000	2.22
Booth Equipment	6,000	4.44
Carpets and Draperies	4,000	2.96
Pipe Organs	12,000	8.88
Seats	10,700	7.93
Light Fixtures	1,500	1.11
Vitaphone	13,000	9.63
Total	$273,200	$202.3

THEATRE NEIGHBORHOOD HOUSE—"B"

3250 Seats—average price of ticket $.50

	Cost	
	Total	*Per Seat*
Land	$200,000	$ 61.50
Building and Architect	600,000	185.00
Equipment		
Lighting Fixtures	6,000	1.85
Stage Equipment	26,000	8.00
Decorations	15,000	4.62
Asbestos Curtain	3,000	.92
Booth Equipment	25,000	7.75
Electric Signs	10,000	3.08
Draperies	5,000	1.54
Furniture	10,000	3.08
Pictures	2,000	0.62
Vacuum Cleaner	1,000	0.31
Carpets	13,000	4.00
Stage Sets and Proscenium Curtain	9,500	3.00
Seats	35,000	10.77
Total	$962,500	$296.04

THEATRE "C" IN A CITY OF 20,000

780 Seats—average price of ticket $.30

	Cost	
	Total	*Per Seat*
Land	$ 30,000	$ 38.40
Building	58,300	74.75
Equipment		
Organ	18,000	23.00
Seats	5,500	7.05
Electric Signs	1,500	1.95
Carpets	2,500	3.20
Draperies	1,000	1.30
Booth and Vitaphone	15,000	19.40
Decorations	1,900	2.40
Total	$133,700	$171.45

THEATRE CHECKING LIST

PREPARED BY A. D. HILL, THEATRE ARCHITECT

I. ENTRANCE

A. Ticket Booth

1. Ticket Vending Machine
2. Change Maker
3. Ceiling Ventilator
4. Electric Heater
5. Money Drawer
6. Brass Speaking Hole and Shutter in Glass
7. Shutter Over Lower Hole in Glass Above Vending Machine.

B Vestibule and Lobby

1. Display Frames
2. Photo Frames
3. Photo Frames in Door Panels
4. Exit Signs over Doors
5. Sand Jars for Cigarette Butts
6. Sockets and Standards for Brass Rails
7. Plush Covered Chains and Hooks
8. Ticket Chopper
9. Electric Outlet for Same
10. Cove Lighting
11. Chandeliers
12. Sinkage for Rubber Mats

II. STANDING SPACE

1. Capping on Rail
2. Glass Wind Screen
3. Recessed Radiators
4. Drinking Fountains
5. Cup Receptacles
6. Rubber Mat
7. Sinkage for Carpet and Carpet Strips
8. Marble Base on Standing Rail

III. STAIRCASES

1. Materials
2. Rails Both Sides
3. Closet for Electrical Panel
4. Electric Signs for Coming Attractions
5. Electric Signs over Doors
6. Empty Conduits to Flasher Room from Signs

IV. AUDITORIUM

1. Width of Aisles
2. Elevations
3. Step Lights and
4. Chair Lights
5. Exit Doors to Open Clear of Passageway
6. Orchestra Rail and Steps
7. Electric Outlets for Musicians
8. Empty Conduits for Organ Wiring
9. Galv. Iron Pipes from Organ to Blower, Console and Relay
10. Obtain Size from Organ Contractor
11. Stud Frame for Shutters in Organ Chamber, Blower Room and Air Inlet
12. Organ Heater
13. Telephone Pay Station
14. Elevators and Machinery Room
15. Angle Irons on Edge of Light Coves for Ladders
16. Method of Relamping all Cove Lighting
17. Walkways Over Ceiling and Access
18. Electric Lights Clear of Fresh Air System
19. Electric Lights in Courts
20. Materials of All Floors, Walls and Ceilings
21. Hose Reel Recesses, Standpipes, Sprinkler Tank and System for Stage

V. BALCONY

1. Material for Capping on Rails
2. Bronze Rails on Balcony Front
3. Pipe Rails on Crossovers and Flights of Steps
4. Extra Steps from Crossover to Rows Above and Below
5. Spot Lights in Front of Balcony
6. Step Lights
7. Chair Lights
8. Exit Signs over Doors
9. Drinking Fountain
10. Telephone Pay Station
10. Material of All Floors

VI. MANAGEMENT REQUIREMENTS

1. Stationery Storage Space
2. Poster Storage Space
3. Ushers' Rooms
4. Lockers for Ushers
5. Captain's Room
6. Slop Sink and Janitor's Room
7. Refrigerator System for Drinking Water
8. Flasher Room for Electric Signs
9. Storage Space for Electric Sign Letters

VII. BASEMENT

1. Boiler Room
2. Coal and Oil Storage
3. Refrigerating Plant
4. Transformer Room
5. Contactor Room
6. Motor Generator
7. Meter Room
8. Battery Room for Emergency Light
9. Musicians' Room
10. Music Room
11. Storage Room
12. Workshop
13. Lavatories
14. Sumps
15. Pumps
16. Incinerator
17. Coal Chute
18. Pipe Trench Covers
19. Wheel Guards
20. Childrens' Playroom and Lavatories
21. Prism Lights
22. Steel Stock

VIII. ROOF

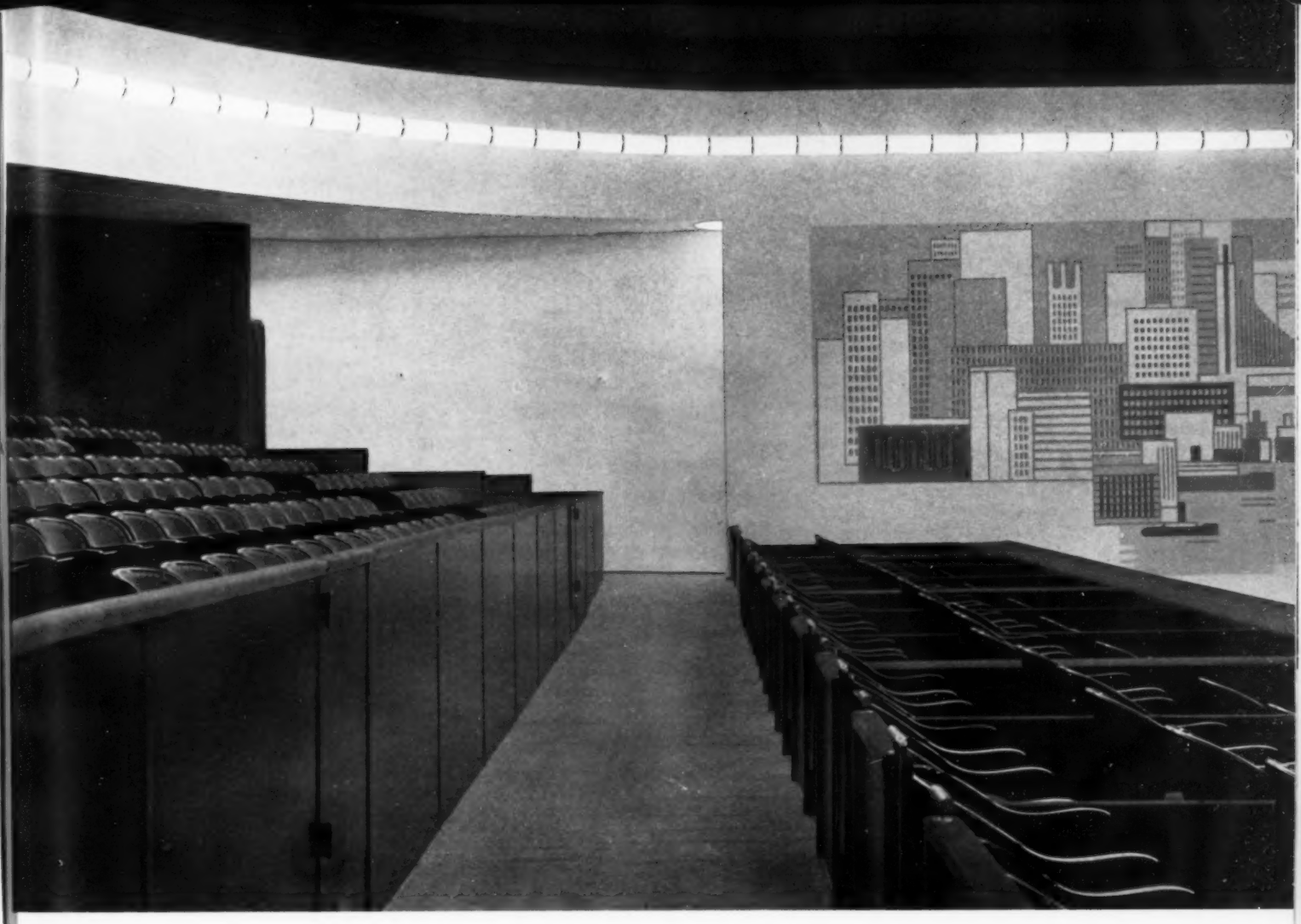
1. Flagpole
2. Tin Clad Doors
3. Kalamein Doors
4. Hollow Metal Windows
5. Pipe Railing for Fire Towers
6. Roof Over Fire Escapes
7. Downspouts and Drains

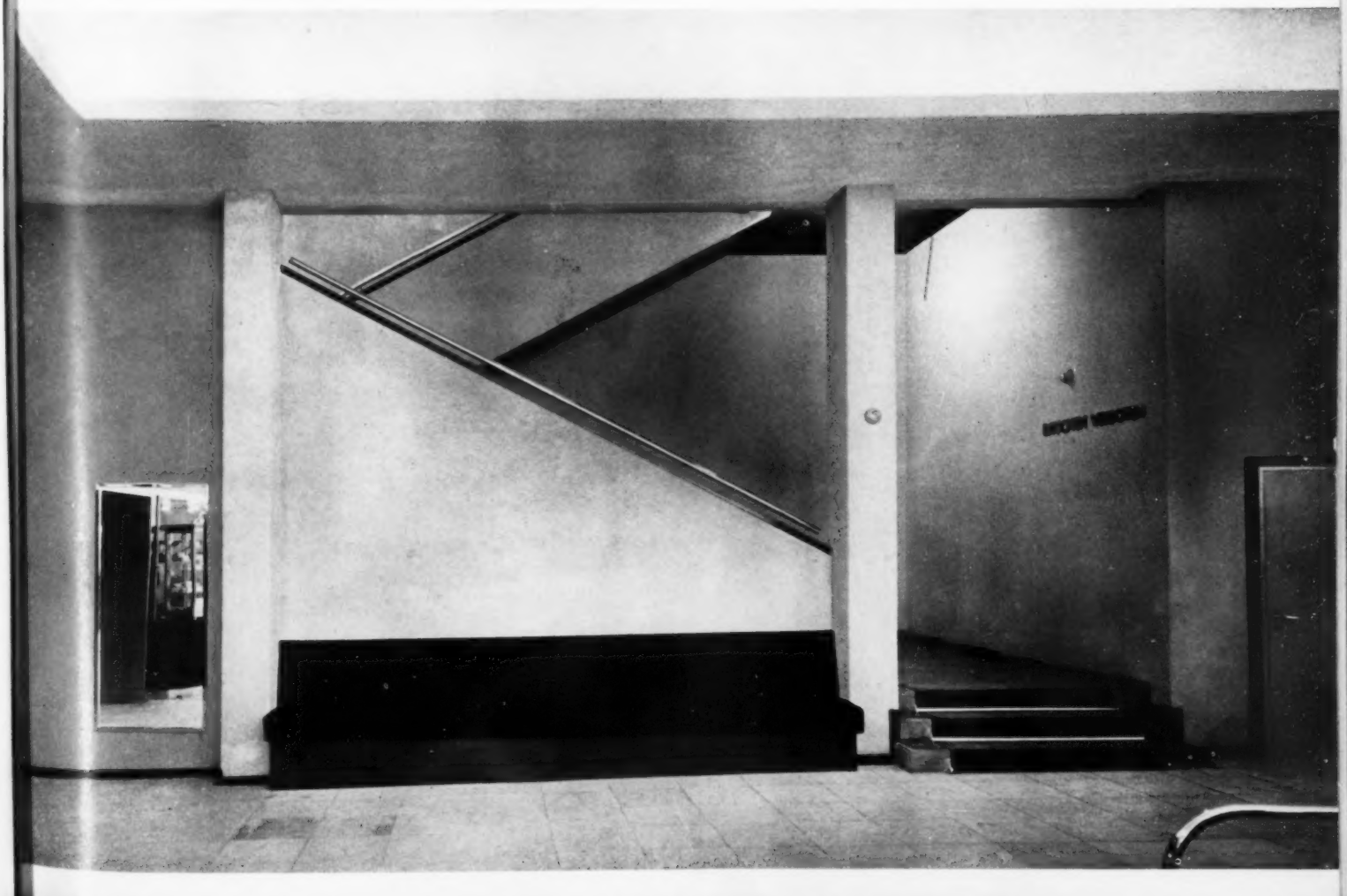
IX. STAGE

1. Scenery Door
2. Vestibule for Entrance
3. Wood Floor on Stage
4. Movable Portion
5. Loose Beams
6. Smoke Pockets for Curtain
7. Footlight Trough
8. Radiation Rear Wall and Skylight
9. Trunks and Baggage to Dressing Rooms
10. Drinking Fountain
11. Shower
12. Steel for Headblocks
13. Ladders to Grid Access to Roof
14. Skylight and Screen Under Skylight
15. Console Elevator
16. Orchestra Elevator
17. Elevator to Dressing Rooms
18. Borders Strips
19. Stage Pockets
20. Exit Lights
21. Angle Iron Frames
22. Subway Grilles
23. Fire Escape and Roof
24. Roof Ventilators
25. Louvres Over Air Intakes
26. Suspended Ceilings and Light Coves

X. MACHINE ROOM

1. Battery Room
2. Store
3. Music Room
4. Rewind Shelves and Cabinets
5. Air Inlets
6. Fans
7. Hoods Over Machines
8. Rubber Floor
9. Tin Clad Doors or Kalamein





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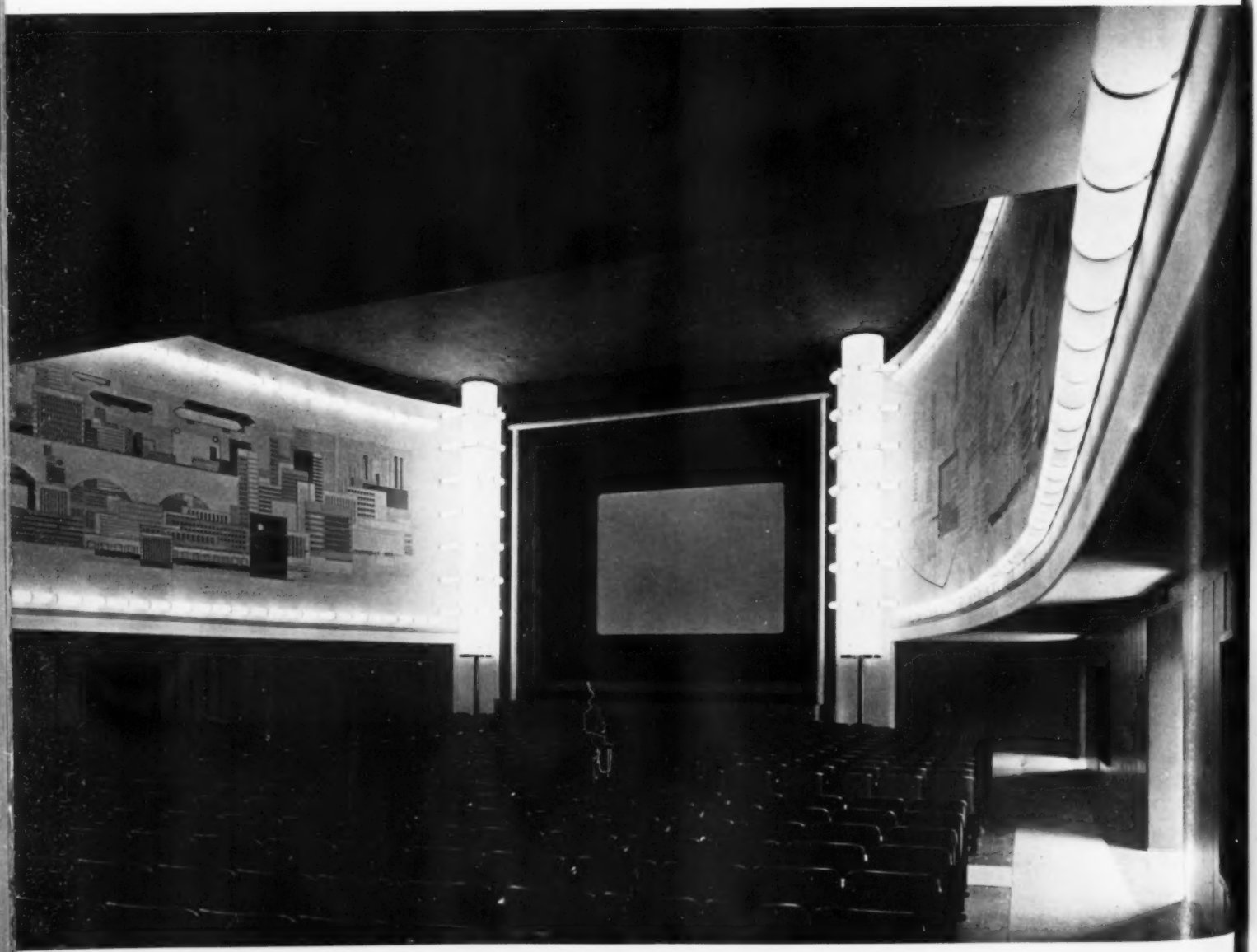


Three views of the EMELKA-PALAST Moving Picture Theatre, Hamburg, Germany; KARL SCHNEIDER, Architect

The first shows the Street Front, the second the Auditorium, and the third the Lobby with the Ticket Booth

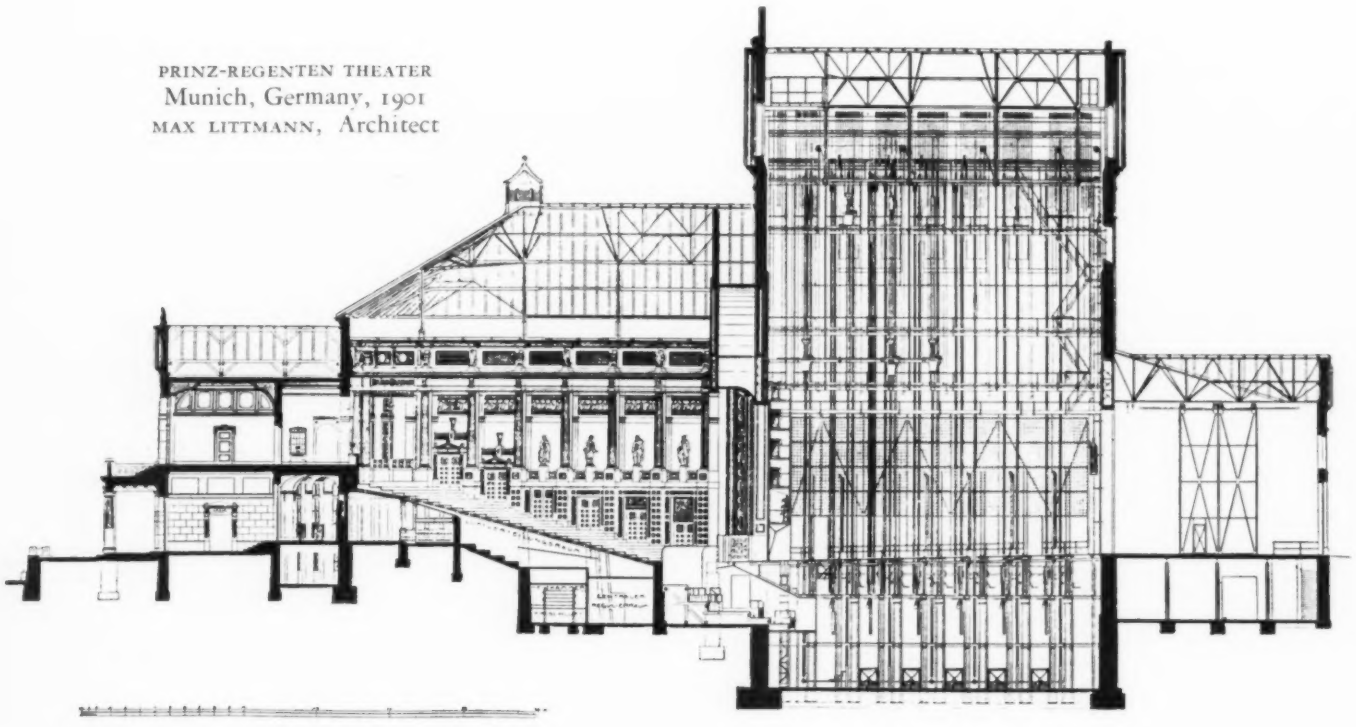
NEW THEATRE ARCHITECTURE IN EUROPE

BY K. LÖNBERG-HOLM

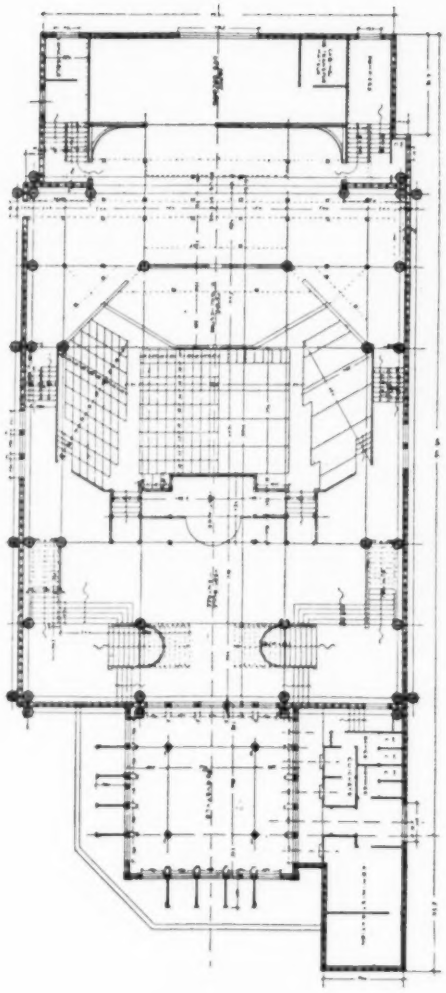
The main function of the theatre plan is the direct transmission of the visual, phonetic and spatial reality of the stage action to the spectator. It is therefore a reasonable demand that the three dimensions of the stage should be equally apprehensible from all parts of the auditorium.

The conventional theatre with its box stage, floor, and balconies, does not permit this necessary precise spatial apprehension of the stage. The sightlines that determine the layout are sightlines from the spectator to the stage opening. To the spectators on the floor, the stage is all ceiling and the stage action becomes a two-dimensional picture projected on the background of the stage. The actors are forced out to the footlights. To the spectators in the balconies the stage is distorted. To the spectators along sides of the auditorium part of the stage is cut off. This stage is satisfactory only for the movie theatre with its two-dimensional screen action; and it is significant that next to the movie theatre, the sports arena (and the cabaret) that offers a spatial reality, today has become the popular showplace.

The rejuvenation of the theatre is not a problem of increasing the mechanical efficiency of the present box stage. Only the placing of the theatre and the drama in a clearly defined functional relation to the community, and a clear understanding of the structural elements of stage action, will lead to a more satisfactory relation between actor and spectator and hence to a new theatre plan.

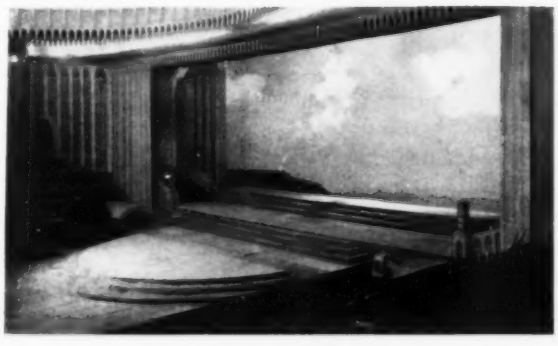


PRINZ-REGENTEN THEATER
Munich, Germany, 1901
MAX LITTMANN, Architect



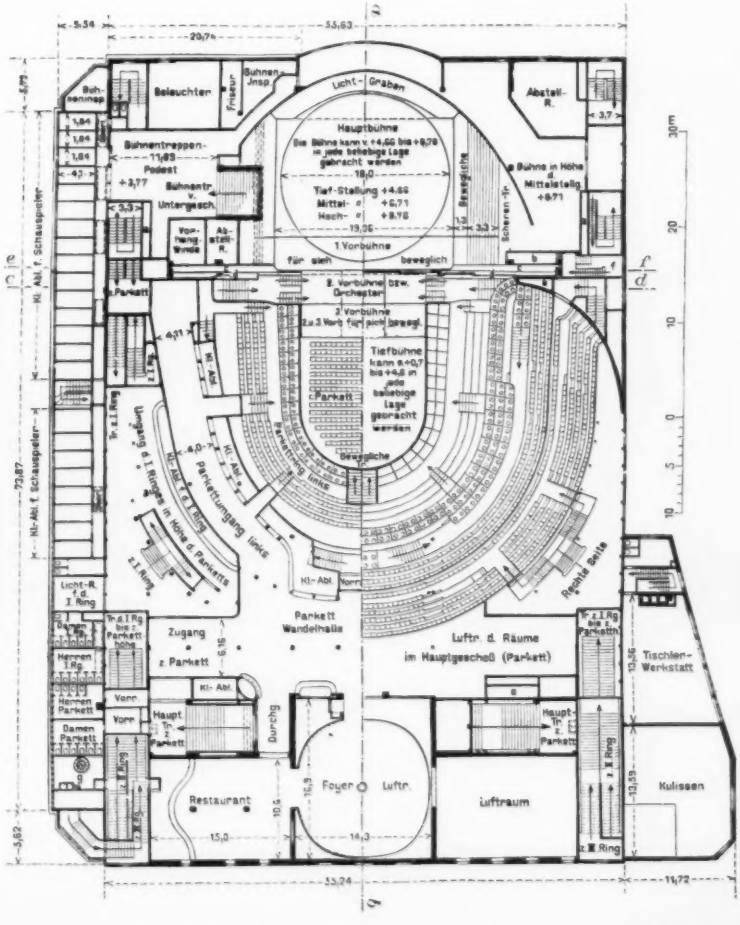
THEATRE in the Paris Exposition, 1925
A. AND G. PERRET, Architects

The stage in three wings commences to encircle the auditorium. This plan and that below by the German architect Poelzig were doubtless developments of Van de Velde's Werkbundtheater at Cologne in 1914.



GROSSES SCHAUSPIELHAUS, Berlin, 1919
HANS POELZIG, Architect

The stage breaks into the auditorium. In front of the main revolving stage are three proscenium platforms. The orchestra floor can be cleared of seats and included in the stage. Variable space relations between stage and auditorium are possible by raising and lowering the different stage sections.


Hauptbühne
Tiefbühne
Beleuchter
Friseur
Abstell-R.
Restaurant
Foyer
Luftraum
Kulissen
Parkett
Zugang
Parkett Wandelhalle
Luftr. d. Räume im Hauptgeschoß (Parkett)
Tischler-Werkstatt
1. Vorbühne
2. Vorbühne
Orchester
Durchg.
Haupt-Tr. z. Parkett
Kl.-Abt.
Vorr.
Damen Parkett
Herren Parkett
Licht-Graben
Bühnentreppen
Podest
Bühnentr. v. Untergesch.
Vorhang Wände
Absteil-R.
Bühne in Höhe d. Mittelstellg.
Beleuchter-Br.
Brückg.
Parkettaufgang linke
Parkettaufgang rechte
Regiest. Seite
Licht-R. d. 1. Rang
Hauptbühne die Bühne kann v. +4,66 bis +8,78 in jede beliebige Lage gebracht werden
Tief-Stellung +4,66
Mittel- " +6,71
Hoch- " +8,78
für sich beweglich
bewegliche
Kl. Abt. f. Schauspieler
Kl. Abt. f. Schauspieler
Tr. z. 1. Rang
Tr. z. 1. Rang bis z. Parkett
Tr. z. 1. Rang bis z. Parkett höhe
Tr. z. 1. Rang bis z. Parkett
Tr. z. 2. Rang
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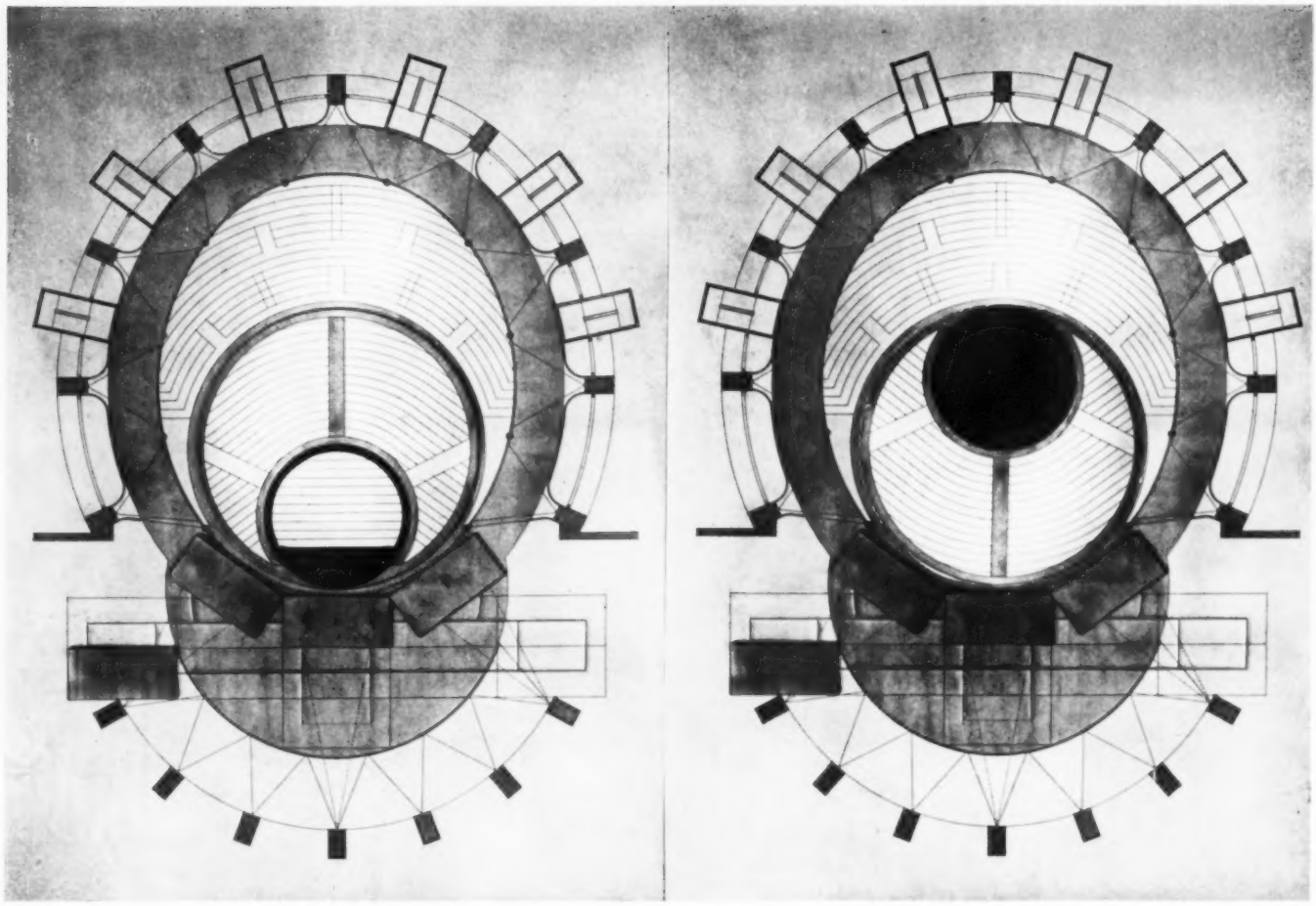


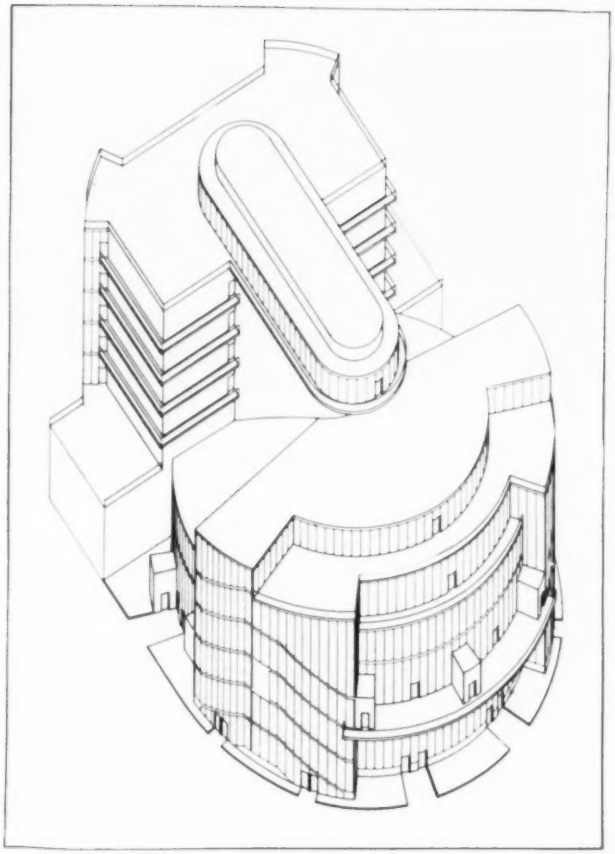
THE "TOTALTHEATER," PROPOSED BY WALTER GROPIUS, ARCHITECT (1927)

This arrangement of a revolving floor permits the same theatre to be used in three ways: circus, amphitheatre, or conventional box stage.

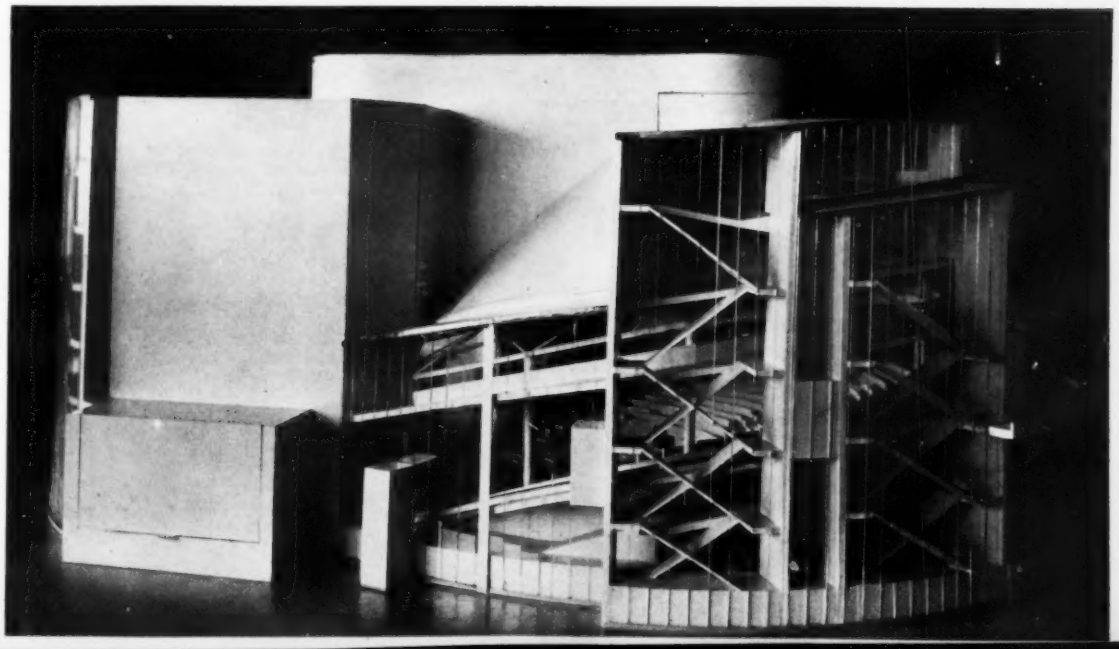
In the plan at the left above, all the spectators face a conventional box stage (with three rectangular wings). What the auditorium looks like may be judged from the skeleton model shown at the top of the opposite page. In the right-hand plan, the floor has been so revolved that an additional round playing space is gained in the center, that can be used either separately or in conjunction with the regular stage. The diagrammatic plans and sections on page 494 show how this is done, and give further details.

THE "TOTALTHEATER" proposed by
WALTER GROPIUS, Architect

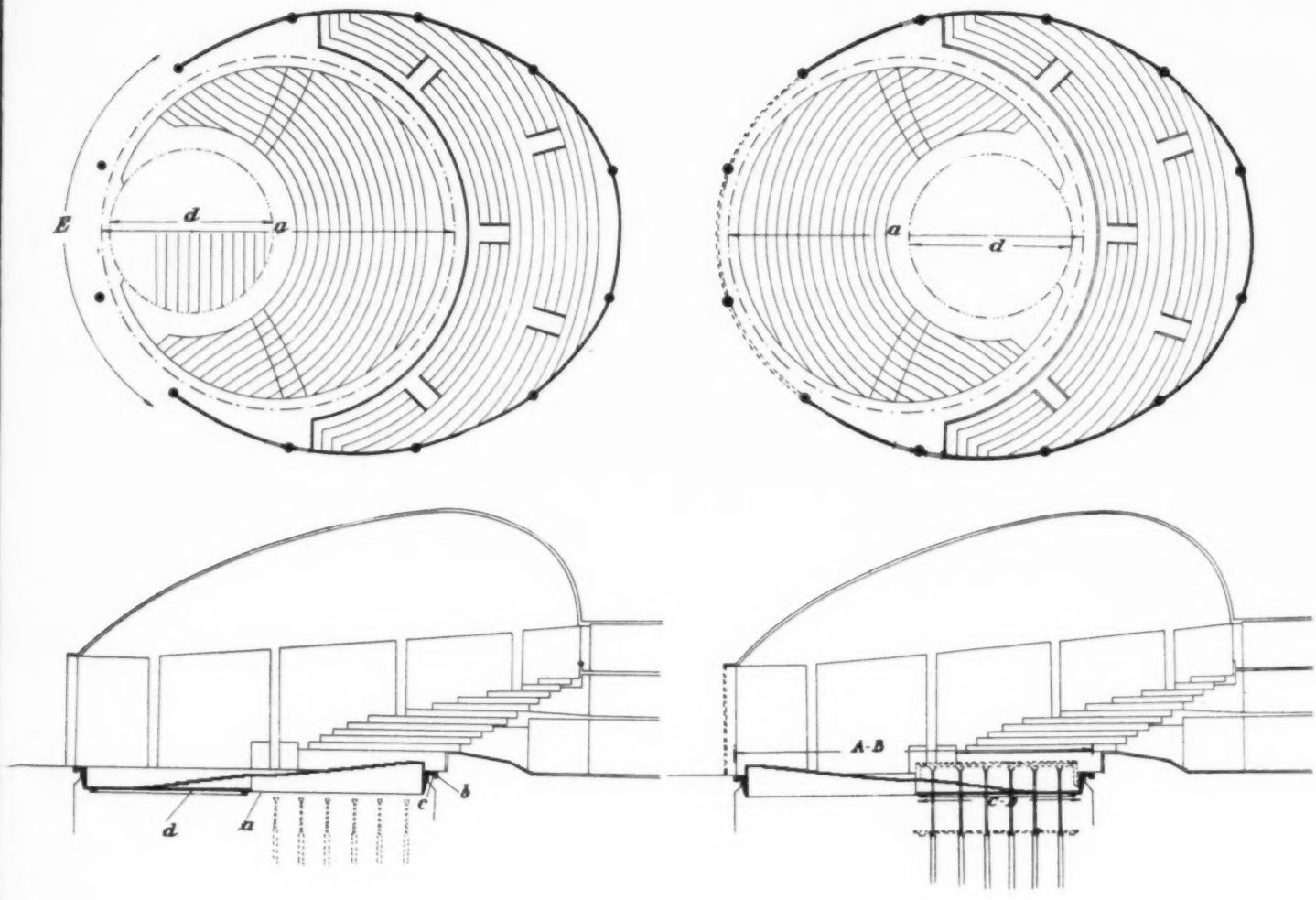
MODEL with part of ceiling cut out
to show construction



DRAWING from auditorium side



MODEL

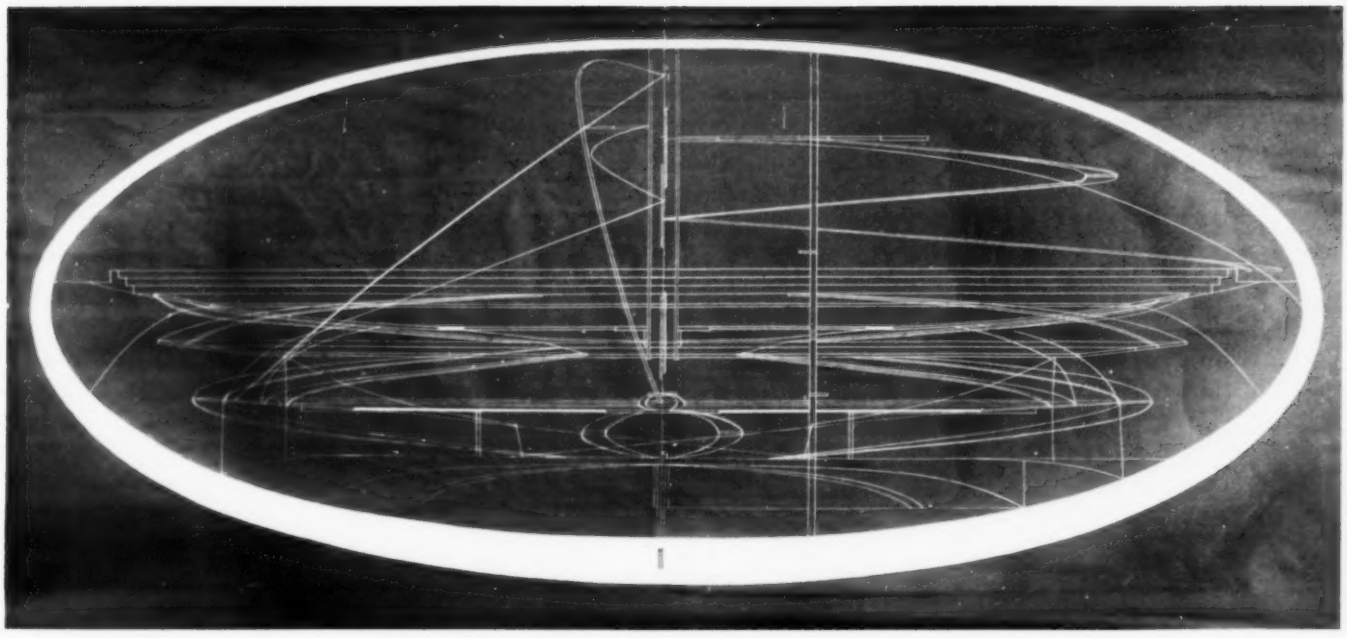


THE "TOTALTHEATER," PROPOSED BY WALTER GROPIUS, ARCHITECT

(See the previous two pages for plans, and for pictures of the model)

The enclosing oval shell is carried on twelve columns. The box stage (E) a triple stage similar to van de Velde's and Perret's, is at one end of the oval, placed within three column intervals partly embracing the proscenium. The stage settings are changed by means of horizontal conveyors. A track extending from the ends of the stage round the theatre and following the slope of the floor makes it possible to extend the stage action around the audience. The small circular proscenium (d) can be lowered, the seats removed, and the platform included in the stage. The actors can enter from the backstage or from the center aisle. A complete change takes place when the circular proscenium floor (a) is turned 180°. This change can be made during the performance. The small circular stage (d) is then located in the center of the theatre. The actors can enter from the aisles, from stairs below the stage, and from ladders suspended from above (vertical approach).

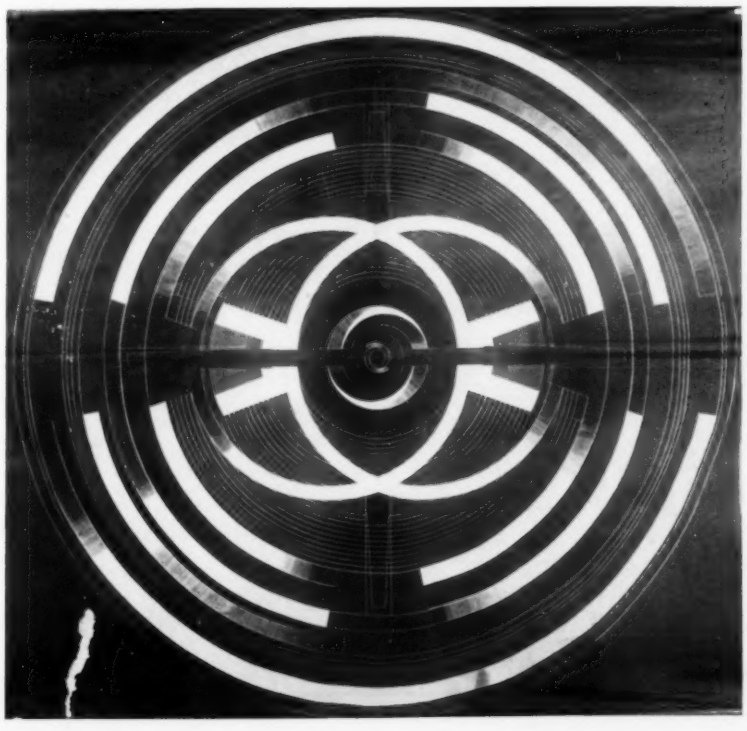
Provisions are made for extensive use of static or moving screen pictures and light effects to support the stage action. Screens between the columns, on the walls and ceiling and the stage background, serve as projection surfaces for light and movie projectors placed outside the columns in a projection room suspended from the ceiling. The spectator is placed in the center of the action. The theatre becomes a flexible space-machine that easily can be changed to meet the varying demands of the stage directors. The audience becomes not only a witness but an active factor in the show.

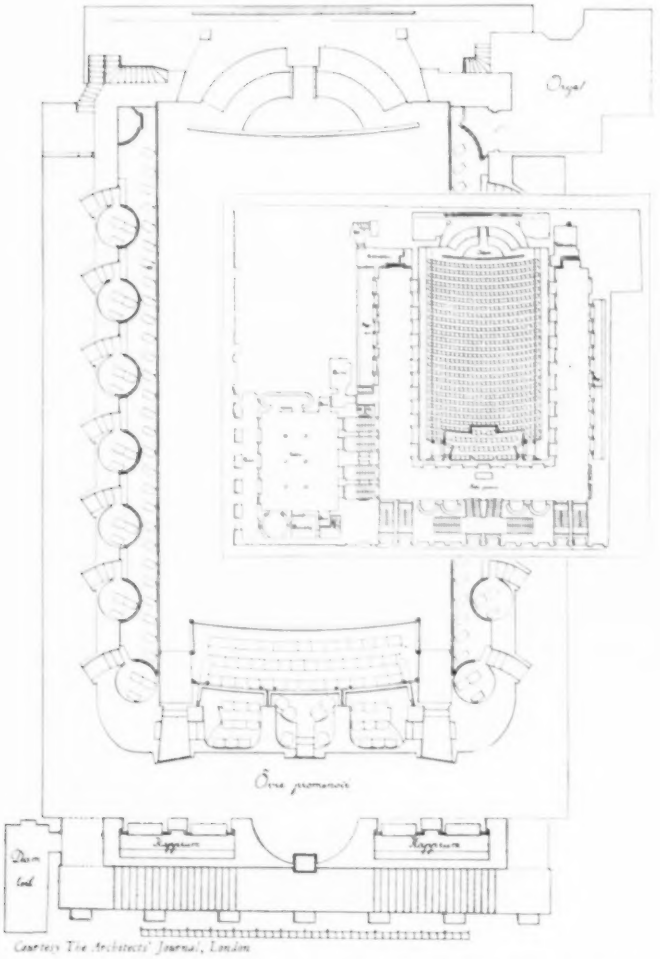


PROJECT FOR A "SPACE-THEATRE" SEATING 100,000 PEOPLE

FREDERICK KIESLER, ARCHITECT (1916–1924)

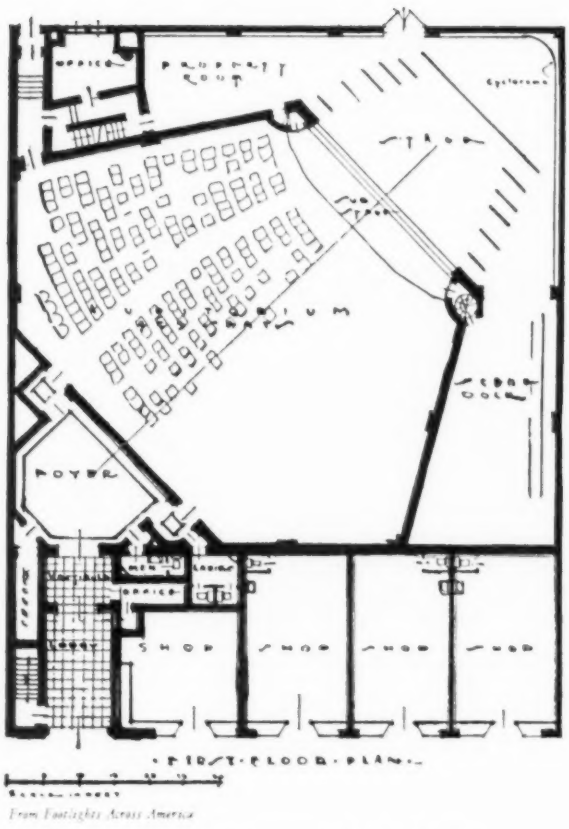
The whole structure is encased in double shells of steel and opaque welded glass. The stage (shown white on the plan) an endless spiral. The various levels are connected with elevators and platforms. Seating platforms, stage and elevator platforms are suspended and spanned above each other and next to each other in space. The structure is an elastic building system of cables and platforms developed from bridge building. The drama can expand and develop freely in space mounted on the spiral. (In the section at the top, only the right half corresponds to the plan below.)





Courtesy The Architects' Journal, London

The SKANDIA, Stockholm, a moving picture Theatre with an unusually fine arrangement of boxes

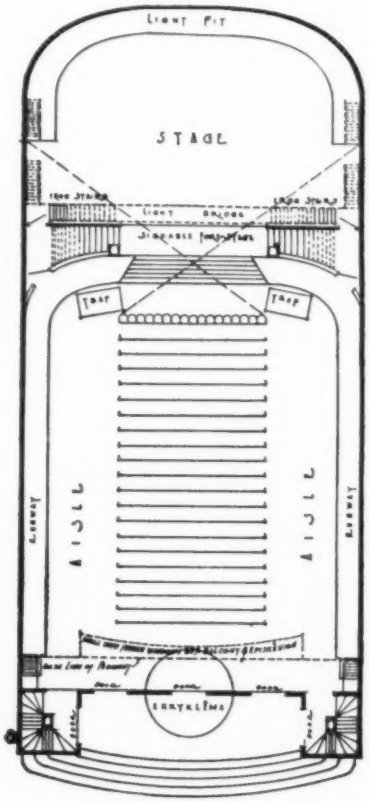


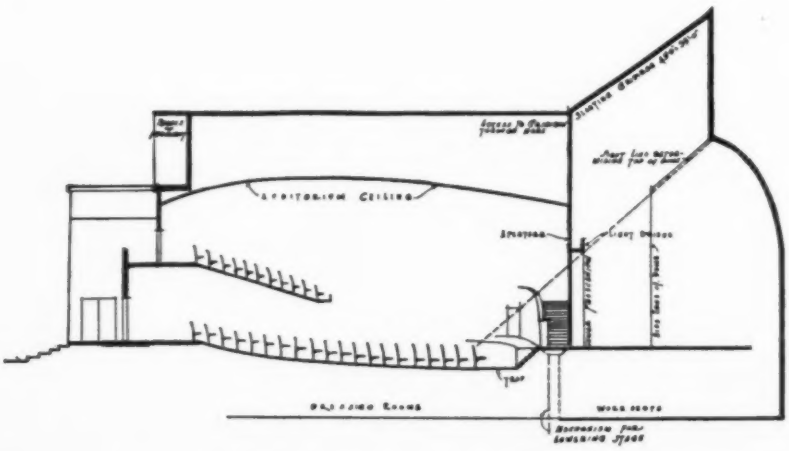
From Footlights Across America

The projected PLAYHOUSE of the Seattle Repertory Theatre

Below and Right: SAMUEL A. ELIOT, JR.'s, project for an ideal experimental playhouse, partially realized at Smith College. An outdoor Greek theatre is shown at the bottom of the plan

Theatre Arts Monthly





For quieter running machinery

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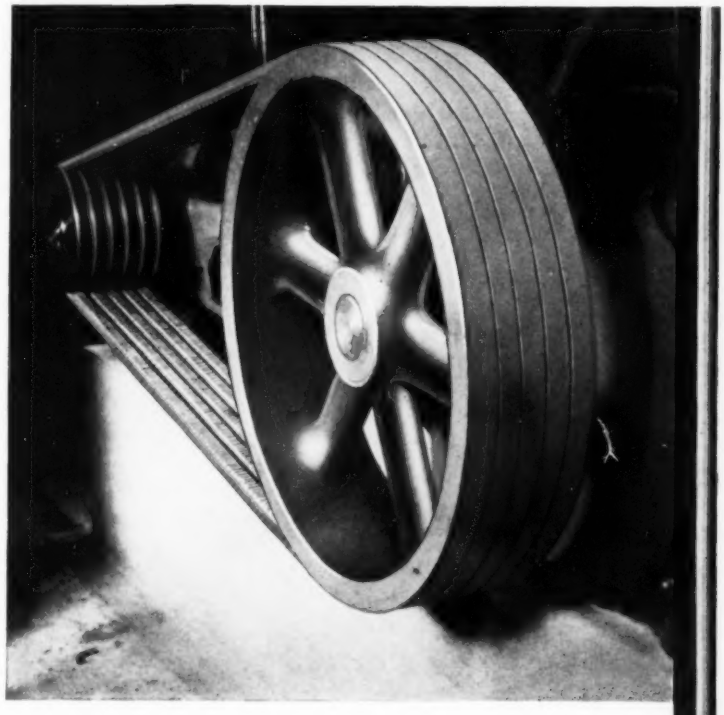
Specify Dayton Cog-Belt Drives



Dayton Cog-Belt Drives have made a revolutionary improvement in the efficiency of power transmission for building equipment machinery. Pumps, compressors, ventilators, conveyors, and similar machinery will give results with Dayton Cog-Belt Drives that you can't get without them.

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ARCHITECTS' ANNOUNCEMENTS

and Notes in Brief

CALENDAR OF EVENTS
GENERAL ANNOUNCEMENTS

May 20-Oct. 1	Exhibition of modern Architecture and Industrial Arts at Stockholm, Sweden.
May 21-23	American Institute of Architects, Sixty-Third Convention, Mayflower Hotel, Washington, D.C.
May 26-30	Fifth International Congress of Building and Public Works, London.
June 9-July 19	Summer session of New York University School of Architecture.
June 19-30	The Fourth Pan-American Congress of Architects and Architectural Exhibition at Rio de Janeiro.
Aug. 4-9	International Exposition of American Import Trade, Grand Central Palace, N. Y.
September	International Congress of Architects, Budapest.
Nov. 18-29	Art Exhibition, Royal Institute of British Architects, London (9, Conduit Street).
1930	Entries in the competition for the most beautiful bridge in North America are invited. Information can be had from F. H. Frankland, c/o Bridge Committee, American Institute of Steel Construction, Inc., 200 Madison Ave., New York City.
In Oct. 1930	The Department of Architecture of the University of New York will begin a series of lectures on "Promoting and Financing Building Projects."

G. N. Beaumont, architect, P. O. Box 1071, Nairobi Kenya Colony, Africa, wishes manufacturers' catalogues and information. It is very necessary that C. I. F. Mombassa costs be given.

The firm of Coolidge and Hodgdon has been dissolved by mutual consent of the partners. The business will be carried on under the name of Charles Hodgdon and Son, architects, 134 South La Salle Street, Chicago.

Charles Corm and Co., Place Assour, Beyrouth, Syria, offer to represent in their market any architectural product manufactured by Architectural Record subscribers which may be suitable to import into Syria.

William J. Creighton, formerly of La Farge, Clark, and Creighton, has moved to 101 Park Ave., where he will continue the practice of Architecture.

Ollie E. Schrickel and Julian H. Blackwell, architects, have formed a partnership for the general practice of architecture under the firm name of Schrickel and Blackwell, 501½ Second Avenue, Decatur, Alabama.

Lancelot Sukert and G. Frank Cordner, architects, have entered into partnership with offices at 301-303 Architects' Building, Detroit, Michigan.

The new address of The F. W. Dodge Corporation offices in Cincinnati is as follows: 507 Building Industries Building, 622 Broadway, Cincinnati, Ohio.

CORRECTION

On page 245 of the March issue of the Architectural Record, under "Apartment house at Nineteenth Street and Second Avenue, New York City," read *Emilio* Levy, Architect.

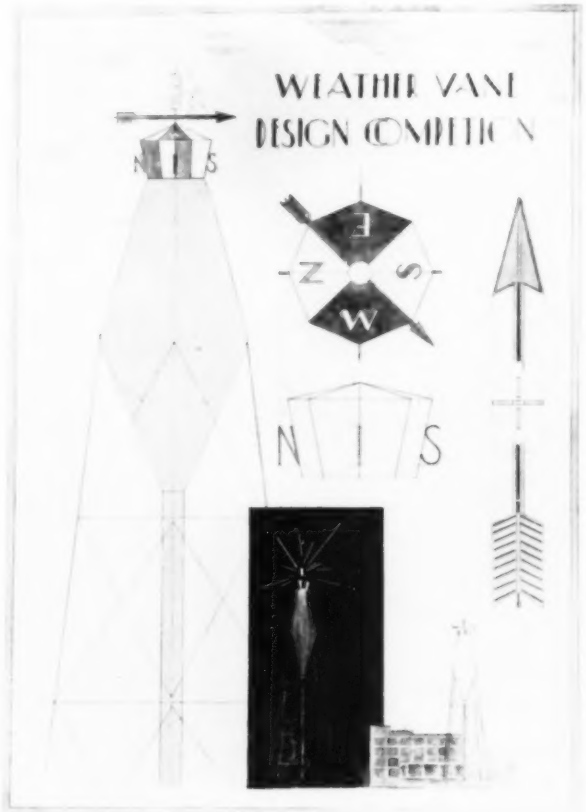
PRIZE BRIDGE

The second annual competition for the most beautiful bridge built in North America is announced by the American Institute of Steel Construction. The award will be made to that bridge opened to traffic during 1929 which is selected by the National Jury of Award.

Two awards will be made this year. One for the most beautiful bridge built for less than $200,000, total cost, and the other for the most beautiful bridge costing more than that. Entries are invited from engineers, constructors and owners. Please address F. H. Frankland, c/o Bridge Committee, American Institute of Steel Construction, Inc., 200 Madison Avenue, New York City.

TERRA COTTA DETAIL PLATES

The National Terra Cotta Society, 230 Park Ave., New York City, announces two series of architectural detail plates: *Terra Cotta Standard Construction* and *Moderne Ornament*. The distribution of the two series of plates will be limited to the architects who specifically request them. No broadcast distribution is contemplated.



Design for a Weather Vane by Carl Kudlich, Scarsdale, New York, awarded the first prize of $500 in the competition for a Weather Vane, sponsored by the Art Alliance with prizes offered by the Carrier Engineering Corporation. The weather vane is to be placed on top of a large water tank at their factory in Newark, N. J., and will symbolize the service they offer in the creation of atmospheric conditions within buildings.

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GOOD TASTE, in a room as well as a menu, demands something that is distinctive, different, and original in character. When you design floors "à la carte," you know you'll get just what you want. Your made-to-order floor is assurance that the whole decorative scheme of the room will be planned on a proper basis.

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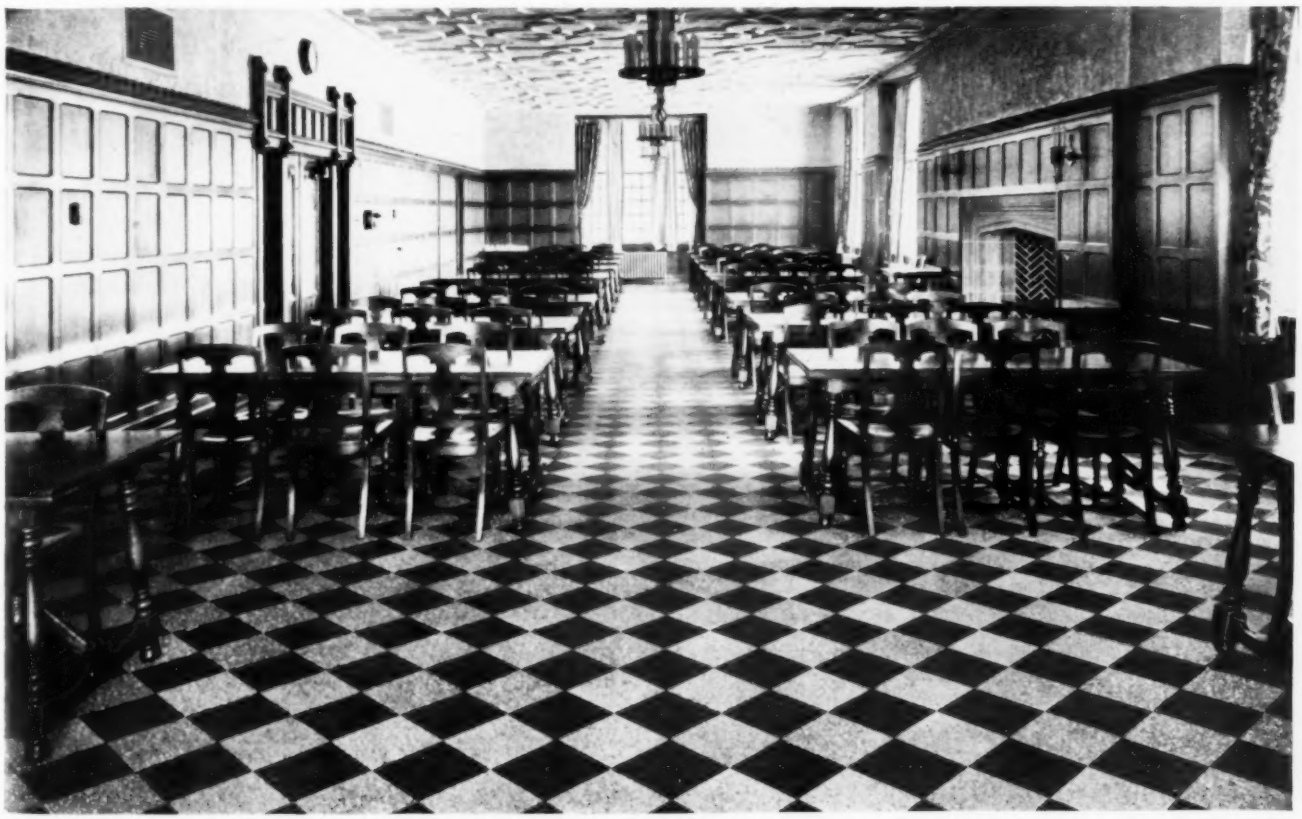
Notice how this Armstrong's Cork Tile Floor blends with the decorations of Notre Dame Academy's dining-room, Cleveland, O. This interior was planned by Thomas D. McLaughlin and Associates, Lima, O., architects.



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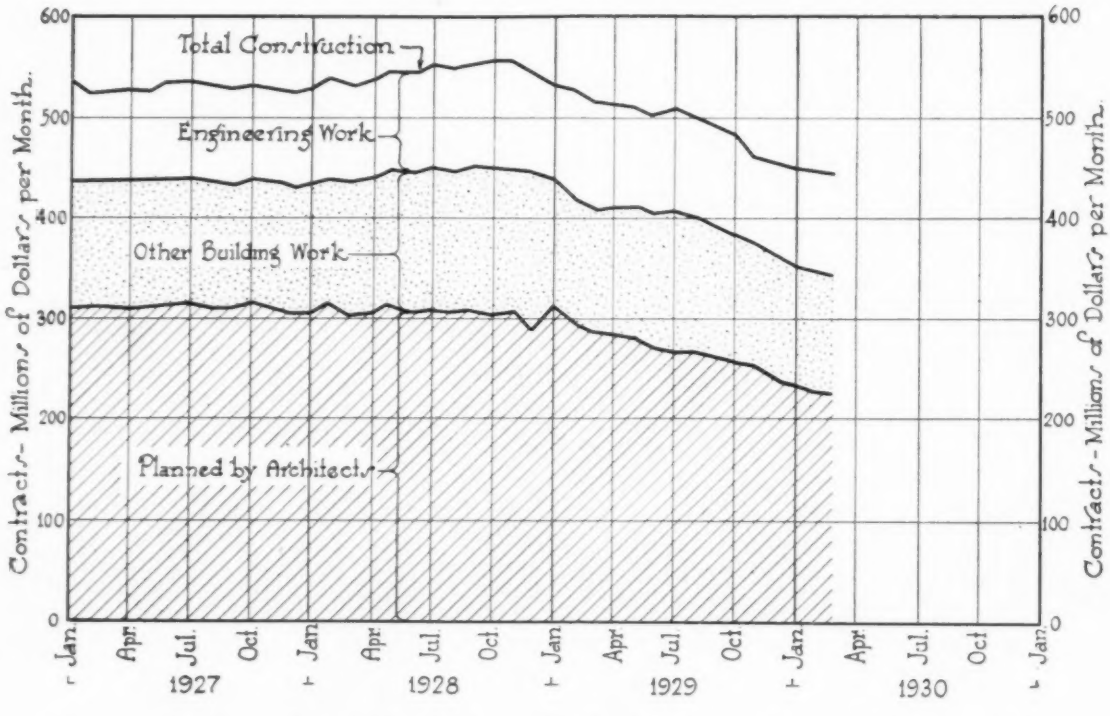
CONSTRUCTION STATISTICS

From the records of F. W. DODGE CORPORATION, Statistical Division. The figures cover the 37 states east of the Rocky Mountains and represent about 91 per cent. of the country's construction volume. They include projects amounting to $5,000 and up.

First Three Months, 1930

	TOTAL CONTRACTS		WORK PLANNED BY ARCHITECTS		
	Number of Projects	Valuation	Number of Projects	Valuation	Per Cent. of Total
Commercial Buildings	5,729	$206,957,000	2,180	$166,821,700	81
Industrial Buildings	1,324	146,098,100	469	47,165,200	32
Educational Buildings	723	75,598,200	623	73,377,800	97
Hospitals & Institutions	224	39,363,800	172	34,555,800	88
Public Buildings	284	32,336,600	174	28,022,700	87
Religious & Memorial Buildings	406	25,177,000	278	23,653,600	94
Social & Recreational Projects	516	28,489,900	312	24,948,900	88
Residential Buildings	16,250	242,886,700	4,225	141,249,000	58
Total Building	25,456	796,907,300	8,433	539,794,700	68
Public Works & Utilities	3,112	303,239,900	67	11,781,200	4
Total Construction	28,568	$1,100,147,200	8,500	$551,575,900	50
Total Construction, 1st 3 months, 1929	35,883	$1,255,829,300	10,787	$678,681,000	54



General Trend of Building and Engineering Construction